THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 26. Thursday, December 21st, 1922. No. 331.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
Foundry Competition	503
The British Cast-Iron Research Association	503
How Quality is Produced under Quantity Production Conditions	504
Chilean State Railway Contracts	506
Determination of Silicon in Pig-iron	506
Contracts Open	506
British Empire Exhibition	506
Layout for Electric Tool Steel Plant	507
Swedish Iron and Steel Production	508
Gating, Feeding and Casting	509
The Treatment of Green Sand Moulding Sand	512
An Apprenticeship Course in Foundry Practice.—XXIII.	513
Birmingham Metallurgical Society	514
American Malleable Castings Association	514
American Methods of Sampling Pig-Iron	515
Book Review	516
Another New American Foundrymen's Association	516
Institution of British Foundrymen	517
Recovery of Molybdic Acid and Preparation of Ammonium Molybdate Solution from Ammonium Phospho-Molybdate	518
The Effect of Special Elements on Cast-iron	519
Blue Constituent in Manganese-Bronze	523
New Installations of Electric Brass-Melting Furnaces	523
Trade Talk	524
Publications Received	524
Patent Abstracts	524
Iron and Steel Markets	525
Deaths	526
Company News	526
Personal	526
Gazette	526

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

PRESIDENT, 1922-1923, Mr. H. L. Reason, M.I.Mech.E., Holloway Head, Birmingham.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.
Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.
Birmingham: D. Wilkinson, 1,114, Bristol Road, Northfield, Birmingham.
Sheffield and District: W. A. Macdonald, 62, Bannerdale Road, Sheffield.
Scottish: W. H. Bound, 69, Minard Road, Shawlands, Glasgow.
London: V. C. Faulkner, 21, Stanley Gardens, W.11.
Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
Coventry: J. M. Meston, 37, Melville Road.
West Ridings of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Foundry Competition.

Iron foundrymen are capable of visualising the competition they receive from other foundries, but it is doubtful whether they realise the inroads which other materials are making into what has been considered their undoubted province. In every section of the trade materials of more recent origin than cast iron are seriously encroaching.

In sanitary ware glazed bricks and earthenware form strong competition. Cast iron cooking utensils are being replaced by aluminium, and earthenware and cast-iron pipes by steel and reinforced concrete. This last material has made tremendous strides, and has stopped the production of many thousands of tons of cast iron for columns and pillars. Steel castings of lighter section, and even drop forgings, form a serious rivalry for cast iron. So one could enlarge *ad infinitum* pointing out how cast iron has been and is being replaced by other material as civilisation progresses. The main materials to be considered are earthenware, where little strength is required, and steel and ferro-concrete, where greater strength is demanded. We purposely included the reference to the march of civilisation, because we desire to put forward that, as all countries have not reached the same stage, there still remains a good market in lesser developed countries for material which commanded a ready sale in Europe some 50 years ago. Producing some of the old-fashioned material by modern quantity-production methods a good market should be found in the lesser civilised countries for domestic consumption. To compete with stronger materials cast iron must be made stronger and so allow of a diminished weight. Obviously, this means research of expensive nature, coupled with propaganda to teach engineers that they can incorporate cast iron of lesser section than has been customary. This dual proposition can only be accomplished by co-operative means, and the only organisation possible is a national one. Fortunately, British foundrymen have had the foresight to provide themselves with an organisation in every way suitable for the purpose. We refer to the British Cast-Iron Research Association. This organisation, after one years' working, can claim the support of nearly 7 per cent. of British foundries. If efficiently conducted it should be of a snowball character and gather weight, but if it lacks the necessary support, the snowball will quickly melt away, to the detriment of British industry. Whilst on this subject we would point out that every foundryman, whether he likes it or not, has to support the Association, as it is Governmentally subsidised on what the Americans term a 50-50 basis. If, however, he desires to get more return for his money than his butcher, he must subscribe directly, the subscription being based on the number of certain specified personnel.

The indifferent position of their malleable industry is being dismissed by British foundrymen with the remark that the Americans have so highly developed the industry that it seems hopeless to expect the British to raise the standard to the plane achieved by the Americans. We would point out that the British boot industry was revived by the introduction of American machinery and methods, and to-day is as flourishing as most industries. Then if boots, why not malleable cast iron. As a final 1922 message to our cast-iron foundrymen readers, we would give this advice: Make yourself *au fait* with all published works on your past, present and possible manufactures and put yourself in position to be immediately advised as to new developments. This will make for a prosperous New Year, more than any expressed wish of ours.

The British Cast-Iron Research Association

At the first meeting of the enlarged General Council held on December 13, at Birmingham, Mr. H. B. Weeks, F.I.C., of Vickers, Limited, Barrow, was re-elected Chairman of the Council; Mr. O. Stubbs, M.I.M.E. (Manchester), and Mr. F. J. Cook (Birmingham) were elected Vice-Chairmen. Both these gentlemen are past-presidents of the Institution of British Foundrymen.

How Quality is Produced under Quantity Production Conditions.

By H. Cole Estep (European Manager of "The Foundry").

(*Continued from page 484.*)

Pyrometic Control.

Nor is the scientific control of the metal, right in the foundry, confined to chemical analysis. For instance, in another foundry cited by Mr. Elliott, pyrometers are being used to determine the temperature of the molten iron at the cupola, in ladles of various sizes, and at various locations in the foundry, with the result that by re-arranging the location of the light and heavy casting floors, altering the sizes of the ladles, and the number of transfers of metal, the quality of the product is being vastly improved. Another foundry, making rolls, is using the optical pyrometer to determine the temperature of the metal as it flows from the furnace. The metal is then held in the ladle until it cools to the exact temperature at which the roll is to be poured. Malleable foundries are also using the optical pyrometer for determining the pouring temperature.

More recently some of these foundries have started to make preliminary chemical analyses of the malleable iron, while it is still in the furnace, as in steelmaking practice, so as to control the composition of the resulting castings more accurately. In a certain steel foundry in America the metallurgist marks the temperature at which the steel shall be poured, on a board which is prominently displayed on the charging floor. The desired carbon content also is indicated on this board. When the heat is tapped out the metallurgist takes the temperature with an optical pyrometer, and, after the metal has been analysed, both the pouring temperature and the analysis is marked up on the board, so that everyone in the shop can see how closely the melter has come to the specifications. This produces a certain amount of competition among the different melters, with satisfactory results. Still other foundries in the United States, making iron as well as steel castings, have been devoting a great deal of study to the electric furnace as a means of improving the quality of metal under tonnage production. In a certain foundry in Cincinnati, the introduction of an electric furnace reduced the defectives of a certain pattern from 35 per cent. to 3 per cent., at the same time increasing the strength of the iron 40 per cent.

It is not difficult in American shops to produce cast iron, to which no steel has been added, under the conditions of chemical control suggested above, with an average tensile strength of over 16 tons per sq. in. Almost any iron foundry metallurgist in the United States, in the better class of shops, has seen many hundreds of heats of iron of 16 to 17 tons strength. These irons are, of course, formulated to fulfil particular conditions, and should not be compared seriously with the product of many jobbing foundries catering to trades in which quality is not a *desideratum*.

Mixing Metal by Analysis.

It has been possible to put the large-scale foundry operations of the United States on an exact basis, largely through the fact that pig-iron is sold exclusively by analysis. No American foundry purchases pig-iron by fracture. Instead the blast furnace furnishes a report showing the analysis of each truck of iron delivered. These analyses are sufficiently accurate for the very small foundries to use them for calculating their mixtures. While many of these foundries do not employ chemists, they almost invariably send samples regularly to outside chemists for analysis. Other small foundries are served by consulting chemists established in different cities throughout the country. These chemists furnish analysis of the product regularly, and also send experts to the foundries, by whom they are employed, to establish and maintain correct melting practice.

Foundries large enough to maintain their own laboratories invariably test all heats chemically and physically. Some of these foundries analyse every truckload of pig-iron as it is received, but it is significant that others have found the blast-furnace analysis to be so correct that they have dispensed with the routine analysis of the pig-iron. All of them, however, test the coke for sulphur and ash, a maximum percentage of each being specified when the coke is purchased.

Besides the routine analysis of raw materials and finished product, the modern foundry chemist is usually busy with research work, in order to improve the quality of his material and standardise the different mixtures, for most foundries use several different compositions of metal and mixtures of iron for the several classes of castings which they make. Grey iron is regularly tested for transverse strength, but as a general rule for tensile strength only in research work. As a rule the engineer specifies the qualities he desires in the castings for the machine or device he is designing. The metallurgist, then, must control the mixture and the cupola so as to produce these results. In other cases the customer provides specifications which the foundry must meet.

The General Electric Company, which has its headquarters at Schenectady, New York, has a number of foundries in different parts of the country, and its procedure for controlling the quality of its castings is perhaps typical of the larger American organisations. At the different works a number of different metal mixtures are used as determined by the metallurgists at the respective plants.

The different grades of castings must meet predetermined transverse tests. For this purpose test bars are cast from every mixture of iron used and tested regularly. While each foundry controls its own mixtures, a general foundry committee composed of the superintendents and metallurgists of all the foundries of the company meets regularly to discuss foundry problems and methods of improving the quality of the iron.

Some Actual Results.

In the automobile industry a large amount of work has been done investigating the characteristics of cast iron and developing methods of laboratory control so that a reliable product may be made under quantity-production conditions. That this work has borne fruit is shown by the records of the Cadillac Motor Car Company. The average cylinder-iron produced by this company, according to H. B. Swan, Superintendent of Foundries, has a tensile strength of 15.5 to 16 tons per sq. in., with a transverse strength on the arbitration bar of 3,500 to 4,000 lbs. The aim in making cylinders is to produce hard barrels of fine-grain-texture, using an iron free from segregation. A cylinder may be perfect and without a flaw as far as leaks, sandholes, blows, etc., are concerned, but if the grain of the bore, after it has been ground to a highly-finished surface, shows under inspection as being open or coarse, the cylinder is scrapped. A portion of the pig-iron used is smelted with charcoal in order to obtain metal of a pure quality. On a cylinder block recently examined which had given 49,000 miles' service, the maximum wear was found to be 0.0015 in. To get such results the Cadillac Company, among many other devices, uses grinding machines for finishing the surfaces of the cores, together with about 250 jigs for core assemblies which are absolutely interchangeable, made of metal, and cost about £12 per set. Every operation is gauged just as in a machine shop. The flasks are made of cast steel and the pins and bushings are ground to a thousandth of an inch.

The American automobile metallurgists feel that not only the amount, but the condition of the total carbon is of prime importance for such work as cylinders. In fact, the question of carbon is receiving just as much attention in American foundries as silicon, although this statement is

contrary to the opinion advanced by a very eminent British foundryman, F. J. Cook, in his Paper read before the American Foundrymen's Association last spring. The same is true of phosphorus and its occurrence in cast iron. Foundry chemists in the United States are now giving earnest consideration to problems connected with the occurrence of combinations of elements in iron such as phosphides, sulphides, etc.

In the motor-car industry special metal mixtures are not uncommon. As an instance of special requirements, H. B. Swan calls attention to an exhaust manifold which was polished all over the outside surface previous to a bake enamel. Being a thin-walled casting with some comparatively heavy bosses and flanges, considerable experimenting was necessary to obtain an iron which fulfilled all requirements satisfactorily.

Where more than one mixture is used Mr. Swan points out the necessity of keeping the different classes of remelt separate so that castings of uniform analysis may be obtained. In other words, the remelt must not be recharged indiscriminately as it is in a good many foundries. If this scrap is properly handled it is possible to vary and control the silicon, manganese, phosphorus and sulphur content easily. Silicon is usually controlled by varying the amount of high silicon iron and steel scrap used; manganese by the use of ferro-manganese, and phosphorus by the amount of steel used and perhaps by the use of high phosphorus pig-iron. Sulphur in high-grade American foundries is controlled to a certain extent through the manganese content, by the temperature of melting and the slag composition. The control of carbon is more difficult because the iron almost invariably takes up carbon to the saturation point, depending upon the temperature and the silicon. A high silicon mixture, that is, 2.75 to 3.00 per cent., with a fairly high sulphur, tends to reduce the total carbon, and this fact is taken into account in automobile cylinder mixtures.

The influence of moulding practice on the quality of the metal must of course be studied. For instance, in automobile cylinder work the sand in the water-jacket-cores and the large barrel-cores holds the heat so long that the surrounding metal is annealed. This is counteracted by using hollow steel or iron arbours for the barrel-cores covered with a thin layer from 3-16 to 5-16 in. of sand. A free circulation of air takes place under the bottom board, through the arbours and through the cope. This procedure will raise the hardness of the barrels from 30 to 40 points on the Brinnell scale. At the same time, a low carbon is desirable, and in most American foundries a cylinder containing from 0.50 to 0.60 per cent. combined carbon and about 2.50 to 2.70 per cent. graphitic carbon is preferable to one with the same percentage of combined carbon and over 3.00 per cent. graphitic.

Nickel in Cast-Iron.

The effect of alloys in cast-iron is, of course, being studied with the object of improving the quality of the metal, and in certain American automobile foundries pistons have been made containing 4 to 5 per cent. nickel which, when machined, give a beautiful surface, extremely fine grain and a strength of 16.5 to 17 tons per sq. in.

Tested Grey Iron.

In order to show that good results are really obtained under these conditions, the writer will cite the testimony of one more American foundryman, R. S. McPherron, metallurgist for the Allis-Challoners Manufacturing Company, Milwaukee. In discussing Mr. Cook's Paper, Mr. McPherron said that on a recent order which had passed under his observation 82 sets of tensile bars cast for a certain job averaged 14½ tons per sq. in., and on another similar order 85 sets of tensile bars averaged 15 tons. These bars represented all the tests made, and were not selected for their high value. Furthermore, they represented a medium grade of material, not the hardest iron made in the foundry, but a material suitable for machining into cylinders, liners, etc. Transverse bars of this latter mixture have gone as high as 4,280 lb. (38 cwt.). Two tensile bars cut from the bore of a liner for a 48-in. dia. gas-engine cylinder, tested by Mr. McPherron broke at 16 and 16½ tons per sq. in.; this liner weighed about 5,000 lbs. with a metal section of 1½ in. The Brinnell hardness was 183 on the finished bore. Another bar tested at the Allis-Challoner Works cut from a full-sized prolongation of a 44-in. cylinder liner showed 17 tons tensile strength. The hardness after machining was 192. This casting weighed 4,300 lb. with a metal section of nearly 1½ in.

American Malleable Iron.

In considering the character of the results obtained in American quantity-production foundries, the effect of co-operative research must not be overlooked. Perhaps the most classic example is found in the activities of the American Malleable Casting Association, with which the British metallurgical public is fully familiar. This association, which was organised largely through the efforts of John A. Penton and others, has practically transformed the American malleable castings industry from the standpoint of quality of product. The Association was organised for the specific purpose of improving the quality of American malleable iron. How well it has succeeded is fully set forth in the able Papers of Prof. Enrique Touceda presented at various times before the American Foundrymen's Association and this year before the Institution of British Foundrymen. Prof. Touceda's published data show that, starting in 1915 with metal averaging 17.75 to 20.5 tons tensile strength and an elongation of from 4 to 9 per cent., it is now not uncommon to obtain test bars of ordinary everyday metal averaging 22.25 to 24.5 tons tensile strength with 17 to 25 per cent. elongation. In a Paper read before the American Foundrymen's Association in 1920 Prof. Touceda says: "We started with low ultimate strength and elongation and made many muffs as we raised the standard, but some weeks ago we received a standard tensile test-bar, among other excellent ones, which shows over 26¾ tons ultimate strength and 33.5 per cent. elongation." This work has been accomplished by banding together the principal producers of malleable castings in the United States into an association equipped with co-operative funds for the purpose of pursuing scientific investigations into the quality of malleable iron. In addition, each member of the Association submits test bars from his daily heats, and in cases where these bars show unsatisfactory results the practice of the shop in question is immediately investigated. The result is the maintenance not only of a high standard throughout the industry, but a continuously uniformly high standard.

Steel Founders' Research Work.

Almost equally important along this same line is the work of the Electric Steel Founders' Research Group headed by Major R. A. Bull, research director. The six members concerned turned out 2,569,327 castings in 1920. These foundries use electric furnace melting exclusively. The fundamental idea underlying the work of the research group is the production of better quality steel castings, and, broadly speaking, the results are obtained through the following means: Frequent meetings of group representatives; investigations authorised at these conferences and conducted at suitable plants; general inspections of each plant by the research director; transmission regularly of reports to and from the director; and the use of the director's office as a clearing house and distribution centre for all technical information of value to the members.

The group's investigations to date have included abrasives, annealing, core practice, facing sand, gas cutting, furnace practice, the presence of slag in castings, welding and others. The interchange of information between the members has been carried to the point of permitting foremen to work in the plants of other members assisting in gathering data.

Stimulating Good Work.

To show how efficacious an organisation of this sort is in improving the quality of the product, it should be pointed out that the research director, Major Bull, makes periodic visits to each plant, preparing reports on them in turn, copies of each of which are sent to all the members. He comments upon such items as shop appearance, safety

XUM

precautions, economy in equipment operation, waste prevention, sand mixing and condition of facing, condition of moulds and cores, furnace operation, condition and handling of metal while pouring, effectiveness of annealing and welding, condition of castings when shaken out and when ready to ship, and efficiency and morale of the shop organisation. No point which has to do with the welfare of the plant or the quality of its product is omitted intentionally.

These reports of general inspections have instilled into each organisation in the association a spirit of healthy rivalry and striving after results. Like the frequent but irregular visits of bank examiners, these inspections by Major Bull furnish an incentive which keeps the working force of each shop on its metal, and in addition, of course, there is the scientific research work of the group previously mentioned.

Each plant in the group not only reports the analyses, etc., of its various heats to the director, but sends to him six sets of drillings from each heat. These drillings are sent to other plants in the group, accompanied only by secret key numbers, for analysis. In this and in other ways the analytical work is satisfactorily checked up and maintained at a high standard of perfection.

The results of the policies of the research group are evident in many small details as well as in the main phases of foundry practice. For example, except where a customer stipulates a different procedure, all castings are carefully annealed: surface imperfections, even of slight extent caused by dirt or slag, are chipped out thoroughly before being welded, and except where, because of frail design, distortion might result, all castings are put through a tumbling barrel to give them a superior finish. Certain castings from each heat are systematically cut apart and machined to ascertain interior soundness and condition.

Constant Watchfulness Necessary.

In other words, control all along the line is the answer, and the only answer, to the quality problem in a modern factory. In discussing grey iron foundry practice, Mr. H. B. Swan, of the Cadillac Motor Car Company, previously quoted, has epitomised this conception in the following words: "With a full understanding of the relations of each element and their functions, together with close melting control, it is not difficult to run an iron mixture from day to day with a small variation in composition. Of course, it is understood," Mr. Swan reminds us, "that accurate information is at hand concerning the composition of all the raw materials affecting the final product, and that frequent analysis, hardness tests, fracture examinations, pouring temperature observations, and physical tests are necessary adjuncts to close control and desirable results." In the writer's opinion these remarks sum up the philosophy underlying the manufacture of a quality product under quantity production conditions. It is all a question of systemised scientific control with plenty of brains and ability on the side of the management.

Chilean State Railway Contracts.

The Department of Overseas Trade has received, through the Commercial Counsellor at Paris (Mr. J. R. Cahill), particulars of a call for tender by the Chilean State Railways for the supply of 10,700 kilos antimony in ingots, 1,200,000 kilos pig-iron, 40,000 kilos tin ingots, 15,000 kilos lead ingots, 4,000 kilos zinc ingots, 3,000 kilos "Cintilla" (for hardening iron), 1,800,000 kilos forge coke, 1,500,000 kilos foundry coke.

Tenders are required c.i.f. Valparaiso, and should be submitted in Santiago by January 17, 1923, or at the office of the representative of the Chilean State Railways in Paris (M. Alejandro Bertrand, 88, Boulevard St. Michel) by January 13, 1923.

A copy of the circular (in French), issued by M. Bertrand and giving further particulars of the materials required, can be obtained by United Kingdom firms interested on application to the Department of Overseas Trade (Room 47).

Determination of Silicon in Pig-iron.*

Brown's Method.

A single or double factor weight, 0.4676 or 0.9351 gramme, of the sample is transferred to a glazed porcelain dish, 15 to 25 c.c. of the nitric-sulphuric acid mixture are added, gentle heat is applied to the covered dish, and the solution is evaporated to pronounced fumes of sulphuric anhydride. The dish is removed from the heat and allowed to cool. Fifty to sixty c.c. of hydrochloric acid (1:10) are added, and the contents of the dish are heated without boiling until the soluble salts dissolve. The residue of silica and graphite is collected on a 9-cm. ashless filter and washed alternately with hydrochloric acid (1:10) and hot water to the disappearance of the soluble iron, and finally with hot water until free from chlorides. The residue and paper are transferred to a weighed crucible and ignited, uncovered, at a moderate temperature until the carbon is completely oxidised, and then for a few minutes at a higher temperature to dehydrate the silica. The residual weight is multiplied by 100 and adjusted in conformity with the initial weight of the sample to find the per cent. silicon

The silica obtained by this method may be slightly contaminated, and, when an occasion demands such a precaution, its purity is determined by volatilisation with hydrofluoric acid. To do this two drops of sulphuric acid (1:1) and 3 c.c. hydrofluoric acid are added to the weighed residue. Gentle heat is applied until all fumes are evolved, when the crucible and residue are ignited at a high temperature and weighed. The loss in weight is silica. The per cent. silicon is calculated as in the preceding paragraph.

Solution Required.

Nitric-Sulphuric Acid Mixture

Nitric acid (sp. gr. 1.20)	...	750 c.c.
Sulphuric acid (1:1) ...	...	250 c.c.

Contracts Open.

Eastwood and Mearns, Renfrew, December 26.—For providing, laying and jointing about 2,500 yards of 9-in. and 1,800 yards of 7-in. dia. cast-iron water pipes, etc., for the District Committee of the First or Upper District of the County of Renfrew. W. R. Copland & Sons, 146, West Regent Street. (Fee, £1 1s., returnable.)

Southborough, Kent, December 28.—For the provision and laying of about 1,500 yards of 10-in. cast-iron water main and 6-in., 4-in., and 3-in. connections to existing branches in the main road, Southborough, for the Southborough Urban District Council. The Council Offices, Southborough. (Fee, £5 5s., returnable.)

British Empire Exhibition.

The Department of Scientific and Industrial Research has nominated, amongst others, the following gentlemen to serve on the Exhibition Committee on Science and Industry:—Sir Robert Hadfield, Mr. H. B. Weekes (chairman of the Cast Iron Research Association), and Dr. R. S. Hutton (director of the Non-Ferrous Research Association).

German Enterprise in Russia.—Dr. Serge, one of the directors of Krupps, in an interview, expressed the belief that the agreement reached between Krupps and Stomaniakoff, the commercial representative of the Soviet Government in Berlin, would be ratified by the Soviet Government. Dr. Serge declared that Krupps had been enabled to take up the concession because the participation of certain British groups had been secured to the extent of 75 per cent. of the capital in sterling value. (See our issue for December 1.) In conclusion, Dr. Serge added that Mr. Urquhart, who had taken recently a prominent part in negotiations with the Soviet Government, had promised to give his support, but neither Mr. Urquhart nor his company were providing any of the capital.

* Method used and published by the United States Steel Corporation.

Layout for Electric Tool Steel Plant.*

By Merle W. Caruthers.

The manufacture of tool steels in the electric furnace is receiving added impetus and, by the use of proper forethought in the laying out of the melting department and storage facilities, it is possible to surpass the highest efficiency previously obtained.

Of course, it is not possible to furnish any set rules that can be universally followed, but an attempt is made in the following article to present a layout that combines the good points found in a number of installations.

Steel Scrap Storage.

The question of storage for melting scrap is obviously an important one. It is the condition of the scrap, with regard to corrosion when charged into the furnace, which determines the amount of refining of the bath necessary, the quality of the steel produced and the life obtained from the furnace refractories. These factors, of course, govern the cost of the finished bar, and their control minimise factory cost.

It is a fact that the analysis of any tool steel does not definitely guarantee that the steel will be suited for the purpose intended even if the chemical composition required by the purchaser has been met. Quality starts farther back than the ladle tests or the check analyses taken from the finished bar by the purchaser. The selection and storage of the raw materials which go to make up the charge are important steps in the production of quality tool steel.

Covered sheds should be used for the storage of steel scrap. Excessively rusty steel not only fails to yield a proper percentage of its weight when melted, but forms a bath that is very high in oxides. These oxides should be reduced to insure the making of a sound steel in any case, and, when present in large quantities, the time and materials necessary to bring about proper refinement are immoderate, and consequently cause a higher priced steel without an accompanying enhancement in quality.

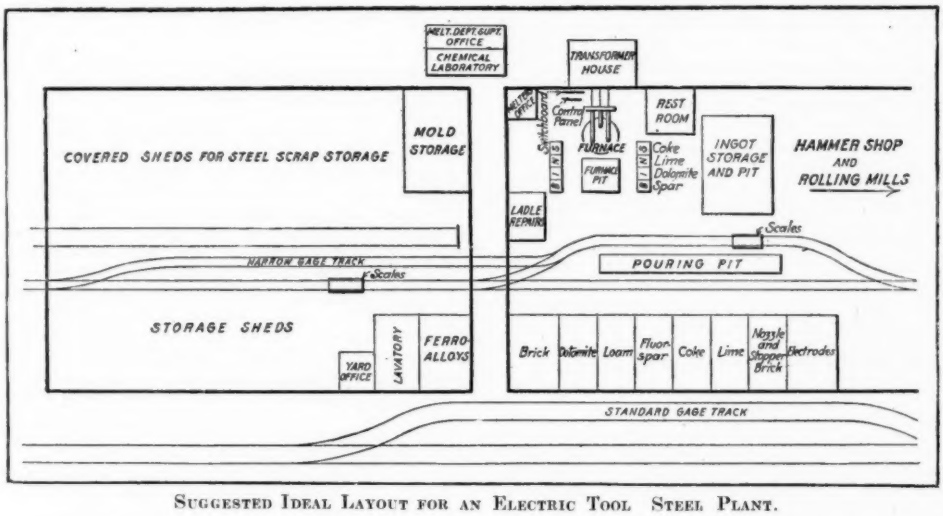
On the contrary, the quality is decreased by using a great quantity of highly oxidised scrap, for no matter what precautions are taken to "tap" under a highly reducing atmosphere, it is practically impossible to obtain a steel free from gases, and the use of rusty scrap necessarily increases the danger of getting a finished product that is not thoroughly deoxidised.

The life of the furnace refractories is shortened by an appreciable amount when the charge in the furnace consists of highly oxidised material, the increased volume of oxides making the ordinary scouring action on the lining even more severe, and hence the furnace is repaired more often. This, of course, means increased cost of repairs and consequent loss of time.

The position of standard and narrow gauge tracks, as shown in the illustration, has been selected to permit the unloading of the incoming scrap and the loading of the charge for the furnace to be performed by the same crane, and, if necessary, without even placing the scrap in storage. This last feature is sometimes advisable when it is desirable to mix heavy and light scrap for the charge without having the crane cover too much distance in doing so. It is convenient to have the track scales for weighing charges situated in the scrap shed, so that cars or bogies, when on the scales, may be served by the crane and the exact weight desired can be furnished without having to make any "shifts."

Mould Storage.

A portion of the shed which is used for steel scrap storage may also be used for the storing of new moulds and sizes not in use. In the first place, the handling of them by the crane means that any desired number can be obtained on a short notice, whereas, if it is necessary to move them by labourers using skids and bars, the time required to get out the same number as by the crane would obviously be greatly increased. Also, the moulds would be kept free from rust by being stored under a covered shed. When split moulds are used, it is good practice to coat the inside surface with pitch or some other suitable protective coatings. The coatings are burned off when the moulds are used for the first time, and the moulds have thus been preserved and the surface prevented from becoming pitted by rust.



SUGGESTED IDEAL LAYOUT FOR AN ELECTRIC TOOL STEEL PLANT.

Melting Platform.

The illustration shows the arrangement of the furnace or furnaces, melter's office, bins and rest room, which make for an efficient operation of the furnace. The question of rest room should not be overlooked, as there are times when the furnace men, and particularly the pit men and ladle men, can rest for a while, and if a room is provided near their place of work it will be more attractive than to crawl off into some hiding place where they may be hard to find when needed. This, of course, applies generally to men working at night.

The installation of shower baths in the rest room affords a pleasure and comfort to the majority of men working in the melting department, and their cost would be justified by the benefits derived through better health of the employees. One of the large steel works in the Pittsburgh district installed four showers in one of their open-hearth departments, employing approximately 200 men, and they are used to capacity with a waiting line at every change of shifts. It is probably impos-

* Extracted from "The Iron Age."

sible to determine just how much good is derived from them, but it is safe to assume that better health is enjoyed by the men who use them regularly.

The melter's office should be built close to the furnace, and should be so constructed as to permit of the accommodation of as few persons as necessary. An error made in the amount of additions to be made would, no doubt, mean a "lost heat."

The storage bins for fire brick, dolomite, loam, fluorspar, coke breeze, lime, nozzle and stopper brick and electrodes should be built so that a standard gauge car could be unloaded directly into them. It is well to have them under the same roof as the furnace, so that material can be transported from them to the furnace without great difficulty and without being exposed to inclement weather.

It will also be noted that materials such as fire and silica brick, electrodes and nozzle and stopper brick, that absorb frost readily, are stored where they are protected in some degree from exposure to the elements. Electrodes and electrode joints should receive special consideration along this line, as excessive electrode breakage will result from using those which have become frozen. They should also be stored where no rain can beat in on them, as moisture is almost as injurious as frost with regard to breakage.

Furnace Pit.

The pit in front of the furnace should be so constructed that ample room is given for the receiving of a ladle larger than the rated furnace capacity. A heat is, at all times, liable to be lost in the pit, and the larger the pit the more readily can any scrap be removed from it. The walls and bottom should be reinforced with concrete, and a liberal radius should be allowed where the side intersects the bottom. This precaution is taken to add to the ease with which steel, which has entered the pit in a liquid state, can be removed after solidification. For this same reason it is good practice to cover the bottom of the pit with a layer of loam about 2 in. thick.

It is desirable, when possible, to have the melting platform, furnace with control panels, bins, etc., elevated about 10 ft. above the pouring platform, but the expense of such an arrangement is sometimes considered inadvisable. In case the melting and pouring platforms are on two separate levels, it is obviously unnecessary to have a pit, as the ladle for receiving the heat can rest upon its trunnions, supported by standards placed on both sides of the ladle for this purpose.

Ferro-Alloy Storage.

The cost of ferro-alloys and the ease with which some of them can be mistaken for each other makes it expedient that they be kept in bins in a general storage room made especially for them. This will also have a psychological effect upon men held responsible for getting the alloys to the furnace, as the more orderly the condition of the storage house the more care will be taken in keeping them in separate piles about the furnace.

The writer recently visited a steel works using ferro-manganese and ferro-chromium, and noticed a pile containing approximately 1½ tons of what looked at a distance to be either ferro-manganese or ferro-chromium. Upon making inquiry, it developed that an inexperienced labourer had mixed 1,100 lbs. of ferro-manganese with a pile of ferro-chromium, and the resultant mixture was of no use because of the fact that no heats were made at that plant using those amounts of manganese and chromium in combination.

This is an example of carelessness that is not uncommon around a steel works, and, although the amounts involved in this case are larger than are required in an electric furnace tool steel works, it still remains a fact that setting the right example for some workmen in maintaining orderly looking storage houses has a decidedly lasting and desired effect upon the men taking materials from them.

The making of quality steels by the electric furnace process necessitates the running of preliminary analysis on such elements as carbon, manganese, chromium, etc., and the holding of the heat in the furnace until the results of the laboratory have been received. When the laboratory is near to the furnace, much time can be saved.

Ingot Storage.

Ingot storage facilities should be arranged so that it is possible to bury ingots hot in a pit if desired or to store them cold in piles. Heat numbers should be stamped or marked legibly on each ingot, and the ingots should be piled in such a way as to have their identity outward and easily obtained.

General Remarks.

Tests which are being made from day to day to determine the physical properties of different grades of tool steels show that one company's steel may be of higher quality than another's, although they have, in all probability, bought their alloys according to the same specification, used the same grade of scrap, melted to the same chemical composition, and cogged their ingots at the same rate of reduction and at the same temperature. The difference is due to the fact that the first company has learned that quality must be injected at every stage of manufacture, while the second company, overlooking this fact, has only met the chemical requirements.

We are slowly realising that hit-or-miss methods have no place in present-day steel manufacture, and also that the physical requirements of any tool steel are far more important than the chemical composition. It remains for some standard testing apparatus to be designed that will reveal the true requirements of tool steel, and, until that time comes, the greatest safeguard against poor quality is by using steels that have been made by up-to-date manufacturers using up-to-date methods and equipments, and controlled by up-to-date supervision and design.

[The layout exemplified by Mr. Caruthers presents many excellent features, but we would suggest that the system of filling and emptying the scrap storage sheds is liable to result in the constant use of new material and the leaving of the old at the back of the shed to rust away over indefinite periods. To our mind the sheds should be filled from openings in the outside wall, the system apparently adopted for all other materials. Additionally, we suggest that a broad gauge track running past the chemical laboratory and the transformer house would allow of the rapid despatch of transformers to the manufacturers should they burn out. The superintendent's office and laboratory we would fit into the corner made by the melter's office and transformer house, providing a hatch between the laboratory and melter's office sufficiently large for the passage of samples. This would save much time. A further suggestion is that room should have been allowed for the incorporation of a second melting unit should the business of the concern increase sufficiently to warrant it.—ED.]

Swedish Iron and Steel Production.

The Commercial Secretary at Stockholm (Mr. H. Kershaw) has informed the Department of Overseas Trade that, according to the quarterly report of the Swedish Ironworks Association, the output of pig-iron and steel was perceptibly increased during the third quarter of 1922, in comparison with the same quarter last year. For the first three quarters of the year the output of pig-iron was 184,000 tons, as against 257,600 tons during the same period last year (the decrease was caused by the restricted production of the blast furnaces during the first quarters of the year), of steel ingot 226,800 tons, as against 100,400 tons during January-September last year, and of rolled iron 153,300 tons as compared with 83,100 tons last year. The total exports of iron and steel during the three quarters were 125,000 tons (of which quantity 33,700 tons were pig-iron), as against 101,200 tons during the same time last year, whereof 58,800 tons were pig-iron. The imports show diminished figures, amounting to a total of 90,700 tons as against 107,000 tons during the same period of 1921. The number of blast furnaces in operation at the end of October represented about 25 per cent. of the total number capable of working, whereas the puddling and steel furnaces in operation were 33 per cent. and 39 per cent. of the total number.

Gating, Feeding and Casting.

By E. Longden, A.M.I.Brit.F.

(*Continued from page 490.*)

EXAMPLES OF FAULTY AND SUCCESSFUL GATING AND FEEDING METHODS.

It is sometimes amazing the trouble in which the foundryman is involved to secure a good casting of apparently simple design.

The bottom sketch in Fig. 1 shows the section of a casting which might represent a Ramsbottom ring, a valve seating, or any casting of similar form which is machined all over and is required without blemish. The middle sketch shows the usual way of gating the casting. When run in that way wasters frequently occur, due to gas-holes on the top side, mainly on opposite side to runner; also dirty spongy places appear occasionally near runner entrance. Wasters are rarely encountered when employing the method of gating depicted in the upper sketch. It will be seen that an almost continuous ring of spray runners is employed, allowing the metal to be admitted to the mould at a uniform temperature throughout. With such a casting and the two examples following, very good results were obtained on adopting the method outlined.

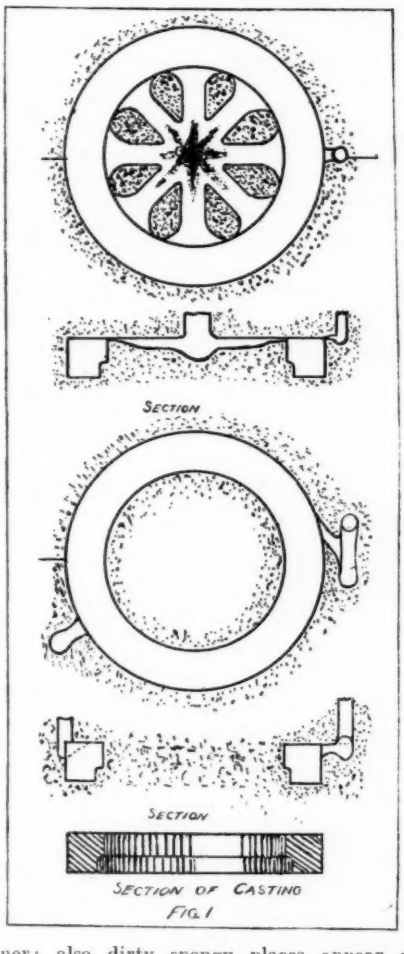


FIG. 1

Gas Engine Valve Head.

Fig. 2 shows sketches of a gas engine valve head quite a simple looking casting. They are required absolutely sound, especially on the seating A. Defects frequently occurred in the places shown in the top drawing, which is the machined shape. The defects were due to gas and shrinkage cavities, which cropped up persistently with the various methods of gating until the plan outlined in the bottom sketches was evolved. Again, a series of sprays was adopted completely encircling the casting. A tapered iron chill core was substituted for the centre sand core. Excellent results accrued.

The successful application of this method tempted the author to try it on a larger and still more troublesome casting—the gas engine valve shown in Fig. 3. It is one of the most difficult castings to produce. A speck, particularly on the seating B, is sufficient justification for rejection. It was quite usual to make three or even four castings to obtain a good one. Previously the usual methods of gating were, as in the case of the valve head, by horn- or cut-gate, as shown in the top right-hand sketch. No really satisfactory results were obtained until employing a ring of runners, as shown in the bottom sketches. The only difference in running between the valve and the two previously mentioned cases lay in the addition of a second ring of runners a little higher up in the mould.

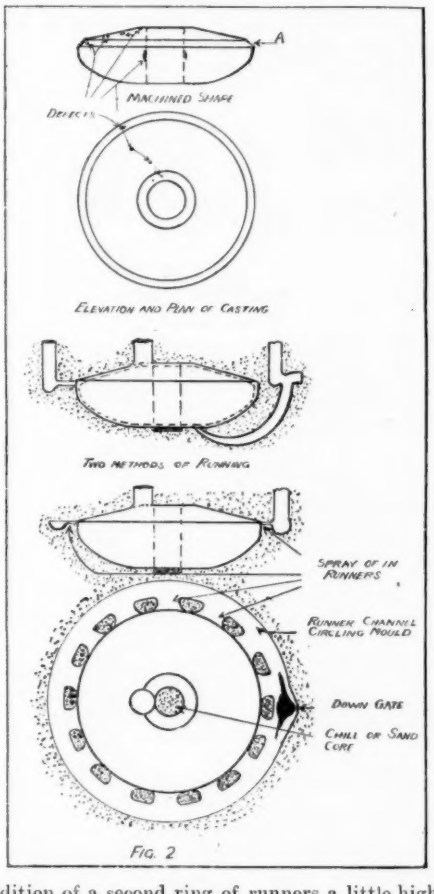


FIG. 2

An explanation of the reason for the success accruing from the adoption of this process of running will suffice for the three castings which have now been mentioned. Again referring to the top right-hand sketch, depicting the old method of gating and visualising, the progress of the entering metal, it will be seen that, if run by one simple in-gate similar to the one marked D, the metal first falls to the bottom side of the head. As the metal rises towards the neck on the other side from the runner gases tend to accumulate there, and are not removed by new clean metal. A hot spot is also formed near the in-runner, and shrink holes appear with the usual attached gas globules. When run by a horn gate, as shown at E, no hot-spot troubles seem to appear, but there is still the occluded gases arranging themselves on the top of the head, as indicated by the arrow at F. The second ring of runners was applied with a view to avoiding the passage of too much metal through the head.

Worm Castings.

Fig. 4 shows a half-sectional elevation of a worm casting and mould. Gated on the side in a variety of ways only produce shrink-holes at the base of the worming. By gating and feeding as indicated in the sketch the trouble disappeared. Here is an instance of a casting being fed through a thin-sectioned runner when constructed in the manner shown. These worm castings were made soundly in both cast iron and steel when gated as described.

Cylindrical Castings.

To run a pipe-shaped casting in a similar way to that shown in the left half-sketch, Fig. 5, very often results in sponginess about the runner. Apart from a hot-spot being formed, it appears, on examining the metal about such a runner entrance, that an extraordinary amount of graphite is present. The graphite would appear to be very much oxidised, too; this is more apparent if metal has been poured "sluggish." It is suggested that the best and easiest way to run is by top-gating, as shown in the right half sketch.

Liner Castings.

Fig. 6 shows a tangent gate adapted to run a short liner about 18 in. deep. It will be noted

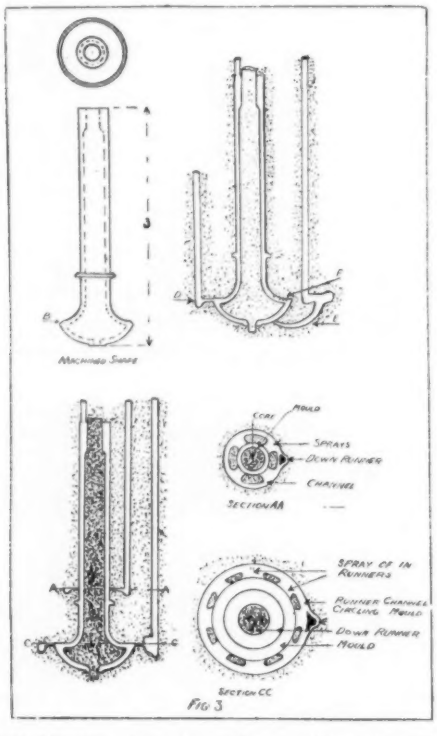


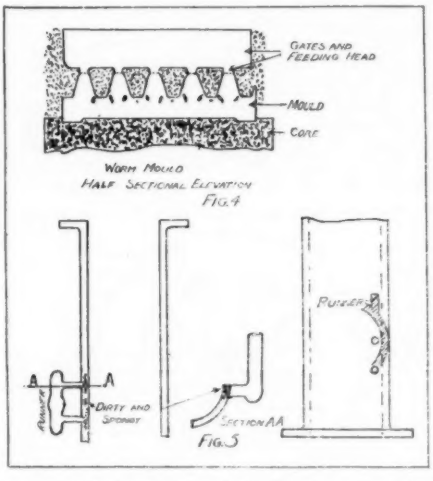
FIG. 3

that the in-gate enters the mould just a little higher than half way. The swirl is then exerted more strongly towards the top, where it is most needed. The in-gate should be formed in a core and tapered as shown. With liners having greater depth, the author strongly favours top pouring. Liners as heavy as 3½ tons are cast very successfully by pouring a small amount by way of a bottom runner to form a cushion to receive the bulk of metal from a series of top gates.

Condenser Bodies.

Fig. 7 gives a sketch of the top end of a condenser body. Some years ago the author was surprised to see such a condenser, about 7 ft. dia. and 12 ft. deep, and with a flange, cast without a reasonable amount of head to receive the scum and feed. Only 1 in. of machining was allowed on the top flange, with the result as one would expect. Cavities were disclosed after machining, as indicated in the upper drawing. An 8-in. head was the means of securing a sound casting.

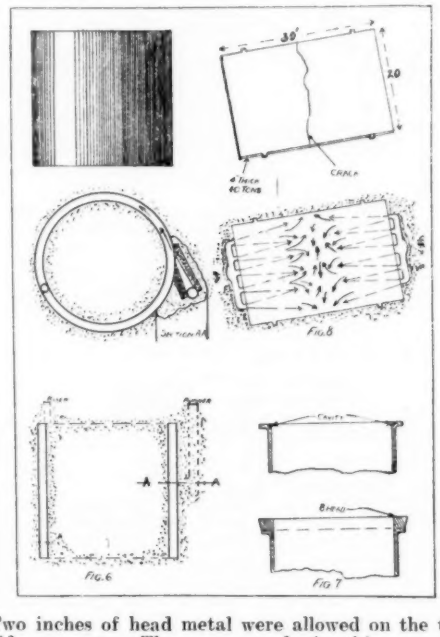
Another interesting incident is recalled by the sketch, Fig. 8. It gives dimensions of a 40-ton plate, cast for the purpose of moulding a turbine housing. The morning after pouring the plate was seen to be cracked completely from side to side. If the directional flow of the metal is followed, as indicated by the arrows, one might suggest that where the streams meet and converge in the centre, a hot line and agitation is set up which resulted in a concentration and excessive growth of graphite, tending for a time, whilst cooling from the solid, to push towards the length of the plate, at the same time contraction would be taking place more rapidly towards the corners. This is one of the reasons why plate-like castings



warp, particularly if gated on the top of the plate.

Cylinder Covers.

At Fig. 9 sketches of a cylinder cover and methods of gating are shown. The top drawing gives the plan and sectional elevation of the casting. Below is seen a faulty way of making them. In this case the flange side is cast down.



Two inches of head metal were allowed on the top side as cast. They were made in this way for many years. About 5 per cent. waste was recorded, due to sponginess at the places A. Wasters were reduced to approximately 1 per cent. when cast in the manner described in the bottom sketch; flange-up, with only the usual machining allowance of ¼ in., horn-gated, poured slowly, and fed through a riser placed over the central boss of metal.

Diesel Cylinder Heads.

Fig. 10 shows a part of the sectional elevation of a Diesel cylinder head. An attempt was made to eradicate sponginess appearing at the points A by employing a heavy tapered riser, as shown in the top sketch. Several hopeless wasters resulted.

The large riser was surrounded with hard strong sand, practically a core sand, and almost touching the bars of the moulding box. It will be apparent that the casting would contract first, leaving the heavy riser suspended between the box bars. A piece of the casting just above the hottest spot under the riser followed, and became suspended along with the feeding head, resulting in a contraction crack as indicated at the place B. An alteration in the bars of the box and with a riser formed similar to the one in the lower sketch, and an application of chills about the porous place mentioned, gave good castings.

Filleting Riser Gates.

Fig. 11 illustrates the right and wrong way to form a button on a riser gate. The sketch on the

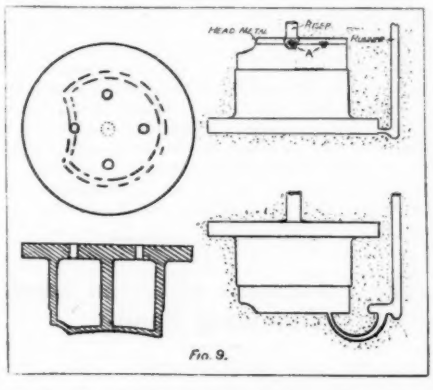


FIG. 9.

right is the wrong way, that on the left the correct way. As is well known, the metal crystals, on cooling, arrange themselves at right angles to the cooling surface. It explains why a riser with a rounded fillet breaks into the casting.

Jacketed Cylinders.

Fig. 12 shows the top side of a jacketed cylinder with wrongly-positioned drop runners.

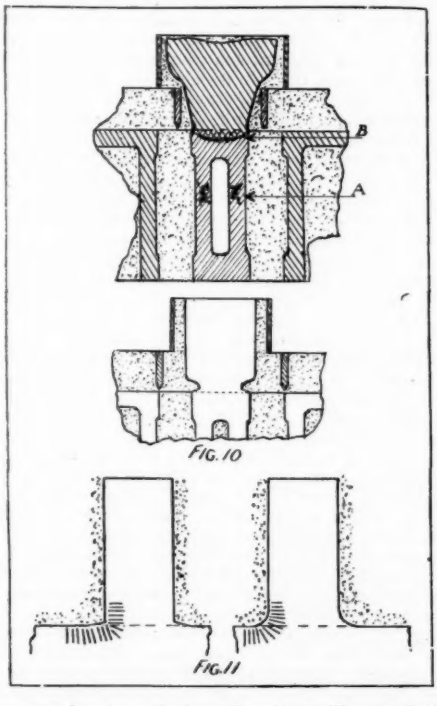


FIG. 10

FIG. 11

An examination of the side view will reveal that instead of the metal falling clear through the mould, the runners direct the flow so that it impinges on the shoulder of the jacket-core scouring it, until a piece of the core between the runners becomes detached.

The next sketch, Fig. 13, shows a part-section of a cylindrical casting. If the mould is deep, and when using top-gates alone, one sometimes obtains a scoured place at the bottom of the mould directly beneath one or more of the runners, in spite of sprigging. The right-hand sketch shows the application of top and bottom pouring, which remedies the evil.

Steam Cylinder.

A steam cylinder is shown in Fig. 14. The manner in which the cylinder is gated will illustrate a clean and successful method of running which, with modifications, can be applied in the gating of various special castings. In most districts such cylinders are cast vertically and gated round the bore with a series of drop runners, as shown in the plan sketch at C. That way is preferable. This sketch is specially shown to illustrate how cylinders up to 3 tons can be, and have been, produced without defects when casting the bore horizontally. Hundreds were made with not more than 2 per cent. waste. The section on line A, A gives a sectional elevation of the mould with gates and runner basin. It will be noted that the metal enters through the flange on the valve side by two in-gates, D. These gates should

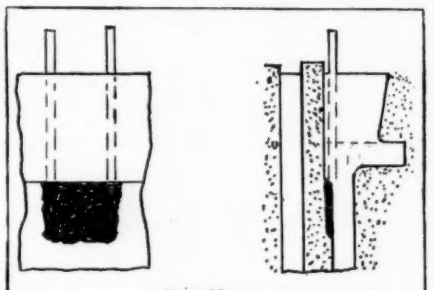


FIG. 12

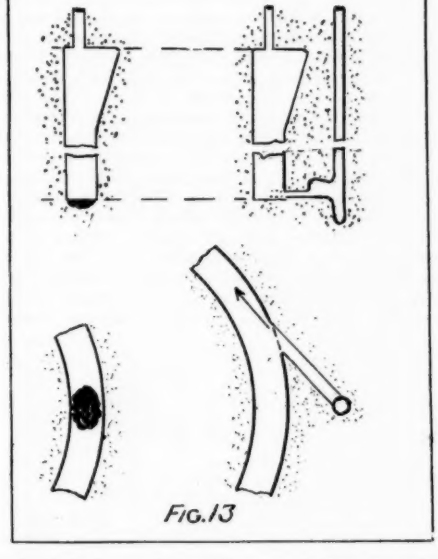


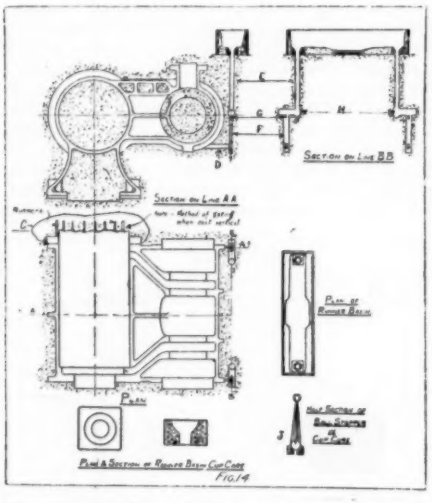
FIG. 13

be formed in a dry-sand core. The plan shows how the gate channels on the joint of the mould are shaped. Section B, B, gives a side view of the down-gates and runner basin. The main down-runners, E, leading from the pouring basin are much larger than the lower down-runners, F, which feed the in-gates, D. A piece of core, G, is placed across the top of the lower down-runners, arresting the flow of the metal and allowing scum to be trapped in the skim-chambers, H. The pouring basin is deep, and not too wide. In the centre, where the metal is first poured, a piece of loam cake is bedded. The mouth of the down-gate, I, is formed in a cup-shaped core. A plan and section of the cup core is seen at the bottom of the illustrations. The mouth is neat, and so formed that the ball-stopper, J, can rest in it accurately without breaking any proud sand and effectively excluding the metal until the runner-basin is full, when the stoppers are lifted.

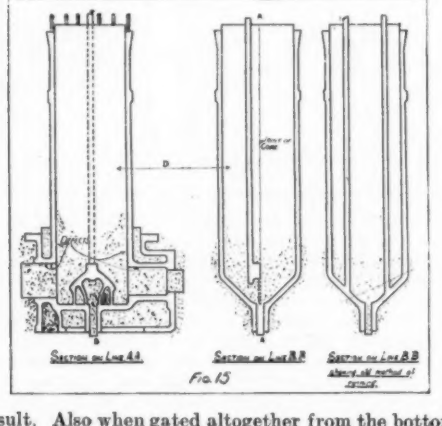
Fig. 15 shows the outline of what might represent a gas or oil engine cylinder. Some hundreds of passable cylinders had been made gated through

XUM

the core, as shown in the right-hand sketch. Gated in that way, the metal strikes violently the core forming the combustion chamber and rushes in the direction of the admission and exhaust branches, where gas and shrink holes were occasionally found. In most cases the defects were disclosed about the places indicated by the arrows. Most excellent castings were produced when they were gated, as shown in the right and the middle sketches. Instead of two runners pounding directly on the combustion chamber core, a combination of top and bottom pouring was arranged.



The core, D, forming the bore and branches, is made in halves, and fastened together after drying. One of the down-runners is rammed up in a half-core below the joint, as in the old method, but with the difference that it does not continue right through the core. As will be seen, it stops short of coming through the core by about 6 in. The blow of the first metal is thus delivered on the inside of the core. Here a skim-chamber is cut to the joint of the core, from which four thin sprays are led gently to the combustion chamber. When sufficient metal has been admitted by the bottom runner the mould is filled by a number of top drop-gates arranged round the bore. Excellent castings are thus produced. When run in the former way the metal which rose up the bore was not the best metal, due to it being a little sluggish towards the top, where it ought to have been the hottest. A porous structure was the



result. Also when gated altogether from the bottom chills, which were placed about brackets between the jacket and outside of bore, soon lost their chilling effect, because much of the metal to fill the bore would wash past them.

It may be interesting to give a few examples of pouring speeds. In the following table the times given are from when stoppers or plugs are lifted.

In a Paper read by E. E. Burgess before the Association of Engineering and Shipbuilding Draftsmen entitled "Notes on Marine Diesel Engine Castings," he stated that an Italian firm, Geo. Ansaldo, have been very successful in the production of Diesel engine cylinders. In casting the large cylinders in one piece, it is usual to endeavour so to arrange the mould that the casting stresses set up will be acting in opposition to the temperature stresses when the engine is working, in order that the two may tend to neutralise each other. This is altogether a matter for long

TABLE I.—*Showing Teeming Speeds for Various Castings.*

Type of casting.	Weight in cwts.	Pouring speed in cwts. per min.
Bedplate—		
$35' \times 8' \times 5' \times 1\frac{1}{4}''$	440	146
Bedplate	140	70
Flywheel	300	200
Steam and gas engine cylinders	50	25
Ditto. ..	20	20
Cylinder pistons ..	7	$7\frac{1}{2}$
Cylinder piston covers	$7\frac{1}{2}$	10

experience in the making of such cylinders. Great precautions are taken in pouring them, castings weighing 10 tons being poured in as short a time as 30 secs. An analysis of the iron used for these cylinders is given as:—Carbon combined and graphitic, 3.81; silicon, 1.36; manganese, 0.87; phosphorus, 0.3; and sulphur, 0.28 per cent.

The Treatment of Green Sand Moulding Sand.

By M. J. COOPER.

In addition to, and apart from its chemical and mineral composition, moulding sand when prepared and in its green state, contains a large proportion of air, and this air has a most important place in governing the functions of the sand when in actual contact with the molten metal. Ordinary green sand when damped and mixed to the proper temper for use, and when passed through a sieve of $\frac{1}{8}$ in. mesh probably contains 50 per cent. of air. The action of ramming displaces the air in proportion to the intensity of ramming. It decides the density and the conductivity and plasticity. Therefore, however carefully the facing-sand may have been selected and prepared, and though its chemical and other properties may be ideal, careless treatment during ramming will nullify all the initial care spent in its selection and preparation.

The rammer should never approach within $1\frac{1}{2}$ in. of the pattern, and then only when using very coarse sand; and after pressing the facing-sand firmly up to the pattern, it should always be carefully borne in mind that the rammed portion of the sand acts only as a retaining wall for the facing-sand, through which ultimately the steam and gas generated will have to escape.

The more the sand is compressed, the more this free air is driven out in the ramming process, the less ventilating properties it retains and when in contact with molten metal, pockets of steam and gas are formed immediately behind the face of the mould, creating pressure zones which, seeking release, flake off the face of the mould and leave the familiar scab. Failing a complete breakway, small jets of gas force their way through the face of the mould and into the metal whilst in its molten state, and create the small gas holes found when the machine tools break through the skin of the casting. These are often attributed to sulphur and other supposed impurities in the metal, whereas careless ramming is usually to blame.

Again, when the sand is rammed too hard the coal dust which has been mixed with the facing-sand, instead of fulfilling its proper function, becomes an element of trouble by creating gas, which, failing to escape through the retaining wall of sand, has to make its way through the body of the molten metal, and eventually as the metal sets, it becomes trapped.

CUMMING & KELLEY, 14, St. Mary Axe, London, E.C.3, have been appointed sole selling agents in London for Pease & Partners, Limited.

An Apprenticeship Course in Foundry Practice.—XXIII.

By Ben Shaw and James Edgar.

DRY SAND MOULDING.

The term dry-sand moulding does not mean that dry sand is used, but sand which, when given the requisite shape, is capable of being dried. Dry sand would be entirely useless in the formation of a mould, but the expression is used to distinguish it from sand used in green-sand moulding, and to determine the class of mould to be prepared for a given job. The sand, when used for a mould to be dried, contains moisture to an amount comparable with a green-sand mixture, and frequently contains more moisture to increase the ease by which it can be worked. In green-sand moulding the moisture content of the sand used must be kept as low as possible consistent with the maintenance of the shape given to it, because of the difficulties experienced in obtaining the ready escape of steam and gases generated when casting, and also because additional moisture occupies space which reduces the permeability of the mould. In a dry-sand mould the moisture is evaporated from it, therefore the mixture of sand used can carry additional moisture to make it more plastic or workable, because the resultant mould is not adversely effected, excepting that additional time may be involved in drying it previously to receiving the metal.

The production of castings in dry-sand moulds is a very important part of the foundry industry, and dry-sand moulders occupy a prominent position in the organisation of the average foundry. Dry-sand moulds are prepared to receive steel, iron and the non-ferrous metals, but more particularly are they invaluable for producing castings in steel and iron. This does not mean that it is necessarily safer to cast non-ferrous metals into green-sand moulds than, say, cast iron, but castings composed of these metals and alloys are, as a rule, smaller—there being comparatively few large castings which necessitate the use of dry-sand moulds—less labour is involved in the formation of these moulds, and there is less risk attached to the production of sound castings because of the work being small.

Generally speaking, the majority of medium-sized and large castings are made in dry-sand moulds, although it must be borne in mind that in some instances comparatively small castings are made in dry-sand, whilst on the other hand castings weighing many tons may be, and are, satisfactorily cast in green-sand moulds. These are, however, exceptions to the general rule, the character and quality of the metal and the simplicity or otherwise of the required casting, influencing the choice of either green- or dry-sand moulds, besides cheapness and quality of the resultant castings. The fact that a mould is dried before it receives the molten metal necessarily increases the cost of such a mould, and this naturally influences the cost of the casting; it is therefore necessary to inquire into the relative value of dry-sand moulding compared with green-sand moulding, and endeavour to show what compensation is obtained by casting the metal into a dried mould.

Advantages of Dry-Sand Moulds.

Castings produced in dry-sand moulds have a comparatively clean skin, blow-holes are not so prevalent, and the structure of the metal is more regular than with castings that are made with green-sand. Thus dry-sand castings are generally sounder and cleaner, and they can be relied upon to a greater extent than those made in green-sand. While this is an important consideration, there would be practically the same need for dry-sand moulds, even though the resultant castings were of equal soundness to green-sand castings. Generally, the moulds for medium-sized and large castings take considerable time and labour to prepare, and the sand gives off much of its moisture in the process, particularly the surfaces against the pattern when an unvarnished or unpainted pattern is used. A green-sand mould depends largely upon the moisture content for its bond, and therefore the surface of such a mould, especially corners of sand, are very fragile. It is admitted, of course, that the mould can be swabbed to restore its strength, but the too frequent use of the swab on the green-sand moulds is generally disastrous to the casting. On the other hand, a dry-sand mould can be swabbed without fear, and since it is a stronger sand, the mould surfaces can be sleeked with greater ease. Then it must be remembered that many moulds for large castings occupy one or two days to core-up and cover preparatory to casting.

With green-sand moulds, unless an oil-bonded core-sand is used, there is the danger of the cores absorbing moisture to such an extent as to make the casting of metal into the mould a very risky undertaking. There is not this danger with dry-sand moulds, and they offer better support for cores, because they are stronger. The amount of metal to be cast into a mould, the speed at which it is poured, and the influence of the molten metal upon the mould, must be considered when determining the relative values of green- and dry-sand moulds. When the cover of a mould is largely exposed to the direct heat of the metal during the time of filling, there is a probability of drawing the cope or causing part of the sand forming the cover to fall on the metal.

A dry-sand mould is not subject to this weakness to anything like the same extent as a green-sand mould. Green-sand is more liable to show signs of the effect of the wash of metal near the runners, and green-sand cannot be rammed sufficiently hard with safety to resist the pressure exerted by the fluid metal in a deep mould. Castings so made are more or less misshapen about the side near to the bottom, due to the presence of swellings caused by the pressure of metal. The surface of a green-sand mould cannot be protected from the influence of the metal so readily as dry-sand moulds, and consequently castings in steel, and sometimes in iron, show sand burnt on them. Many moulds made in dry-sand would be made in green-sand, but greater care would be necessary in the formation, and however much skill was employed, they would be comparatively delicate and more likely to result in waster castings than by using dry-sand moulds. No hard and fast rule can be drawn between work which should be cast in green-sand or dry-sand moulds. In some foundries castings are made in green-sand that would be made in dried moulds in others. It is largely a matter for individual experience, the foreman moulder frequently giving preference to that class in which he has specialised, at the bench or on the floor, as a journeyman. On the other hand, he may be guided by the manner in which previous work has been done in the foundry for which he is responsible.

Sand for Dry-Sand Moulding.

Sand to be dried requires a greater amount of bonded strength than green-sand mixtures, in order to make up for the absence of moisture when dried. Thus, whatever kind of metal is to be cast, the sand for moulds to be dried is stronger than would be used for similar metal in green-sand. For steel castings "Yorkshire," Cornish and Belgian sands are used because of their relative freedom from impurities, a very important consideration for the high casting temperature of such metal. The mixture used for facing varies with the bonded quality of the sand and to suit the class of work to be done. The fineness of the sand, too, is a variable quality, and usually the larger the work the coarser the grain, in order that the mould will be more permeable. For large steel castings, particularly those that are other than mild, composite is more frequently employed, it being less liable to burn on the surface of castings than the previous sands referred to.

The sands for moulds for cast iron are more plentiful, though few can be used without any admixture. Erith sand is one of the exceptions, particularly the darker variety. When old loam is available from work which has been cast in loam it is advantageously employed, together with new sand, in making a facing mixture for dry-sand moulds. With many sands that are weak in bond clay may be added to give the requisite strength; on the other hand, a strong mixture may be weakened by adding blacking, sharp sand or coke. Dry-sand mixtures are preferably milled to toughen them. No coal-dust is added to dry-sand facings for iron castings such as is used in green-sand mixtures. Somewhat similar mixtures are used for the facing sands employed in the making of dry-sand moulds to receive the bronzes and brasses, although the texture is, as a rule, finer. With regard to dry-sand moulds for aluminium, when they are employed, owing to the reduced pressure of the alloy on the mould and the fact that its contraction is considerable, it is better to use a weaker mixture than would be used for other non-ferrous alloys.

Surface Wash on Dry-Sand Moulds.

One great advantage the dry-sand mould possesses over a green-sand mould is the superior skin produced on the casting. This is largely due to the refractory facing applied in the form of a wash. The material used to form the wash varies according to the metal to be cast; thus for mild steel castings the dry-sand moulds are coated with a wash consisting of graphite and flour-silica, to which a good-quality clay, such as china clay, is added, and sufficient water to give it the consistency of cream. For hard steel casting steel-moulder's "compo." is frequently thinned with water and used for the purpose, although graphite is often added.

Mineral blacking is generally the main constituent of the wash given to dry-sand moulds for cast iron, but graphite improves the quality and increases the ease with which it can be sleeked. Clay is frequently used as a bond for this wash also, whilst some prefer a carbonaceous bond such as core-gum, claiming as they do that the sand leaves the casting better, but a clay-bonded black-wash, when carefully prepared and applied, causes the sand to "peel" readily from castings. The blacking, or the blacking and graphite, according to the quality of wash required, is added to water in which sufficient common clay has been mixed to make it well coloured. For large work little, if any, graphite is added as a rule, but for small or medium-sized work of an intricate character and on which a smooth, clean skin is desirable, graphite as an addition to the blacking increases the quality of the wash.

For dry-sand moulds to receive bronzes or brasses graphite is frequently used, especially with the former, but a combination of graphite and French chalk, or French chalk alone, gives a very good surface. Flour or peas-meal is often preferred as a bond for this wash, though clay is sometimes used for the purpose. A similar wash may be used for aluminium, although graphite may be profitably excluded.

The quantity of bond required for these surface-washes is best determined by experimental tests. Too much is as bad as too little, for then the surface to which it is applied cracks on being dried and the wash tends to peel off, whereas when the bond is relatively low it is easily brushed off after being dried. The opinions of dry-sand moulders vary considerably on what constitutes a good wash, but the skin on the casting is the best guide. When the castings show scales it usually reflects upon the quality of the wash applied to its mould, although the method of application may result in the disfigurement of the casting.

Applying the Wash.

Sometimes dry-sand moulds are painted or washed while they are green in order to save time in drying. When this is done a swab should be employed to apply the wash, and care must be exercised in sleeking, a practice which is not so frequently done as formerly, otherwise the thin protective layer of fine refractory material will be removed in places. Usually the moulds are dried before the wash is applied, and a better opportunity is afforded for preparing the mould to receive the wash. It should be applied while it is hot; not too hot, however, but sufficiently so to allow the work to be handled with ease. A brush should be used for painting a dried mould, and the brush marks should be sleeked out to obtain a smooth surface. In many foundries little sleeking is done, the irregularities, due to quick drying, being reduced by using water. The too frequent or careless use of the water-brush removes practically all the protective coating, and reduces the quality of the skin on the resultant casting. Owing to the presence and method of applying washes, castings are not so well defined in dry-sand moulds as in those of green-sand.

Birmingham Metallurgical Society.

Some Aspects of the Mechanical Treatment of Metals.

In a recent lecture delivered before the Birmingham Metallurgical Society, DR. F. JOHNSON (Head of the Metallurgy Dept., Municipal Technical School, Birmingham) drew attention to the fact that metals and alloys are very frequently used in the worked condition. The influence of mechanical treatment differs largely with the temperature at which it is carried out, and it is necessary to distinguish between hot-working and cold-working. For many reasons it is desirable to retain metals in service in the cold-worked condition, e.g., overhead telegraph wires, for only in this way can there be an appreciable economy of metal.

By cold-working the strength, elasticity, stiffness and durability of ductile material are greatly increased, and all the physical properties are affected.

The lecturer dealt with the inner structure of the crystal-grain, the modern conception of the arrangement of atoms in the space-lattice of each grain, and the relationship between types of this arrangement and the working properties of metals. This modern conception is due entirely to recent application of the X-rays to the study of metallic structures, thus reinforcing the knowledge previously obtained from the use of the microscope.

Considerable stress was laid upon the recently advanced "slip-interference" theory of the hardening of metal, either by alloying, cold-working or heat-treatment. According to this idea, "slip" along the planes of weakness in the crystal-grains of ductile metal is hindered by refining the grain, i.e., causing a large number of small grains to occupy the space of a few large grains or by introducing a component which forms a harder constituent than the ductile metal to which it is added and in which it is scattered as isolated grains. The finer these grains, the greater the interference with slip, and therefore the greater strength and hardness. This strengthening effect is of an external character and is in the nature of a reinforcement of soft grains by harder neighbours. "Slip-interference," however, can go further than this, for by careful heat treatment alloys such as duralumin and steel can have their hardness and strength increased enormously as the result of bringing about the uniform distribution of a hard constituent in very fine particles within the soft grains, thus clogging the movement along slip-planes when external force is applied.

The lecturer concluded by reference to recent investigations carried out on the influence of cold-working on metals and alloys in his own department and elsewhere.

American Malleable Castings Association.

Mr. Robert E. Belt, the secretary of the above Association, has arranged for its members to participate in the American Foundrymen's Association's Annual Convention, to be held in Cleveland next May. This is a lead which might be usefully followed by the Institution of British Foundrymen.

American Methods of Sampling Pig-Iron.*

INTRODUCTORY REMARKS.

Rapid determination of the constituent elements of pig-iron, with the exception of sulphur by the volumetric method, is susceptible of a very satisfactory degree of accuracy. With respect to sulphur, the volumetric method is the only one, up to the present, by which the determination can be made within the time limits fixed upon the iron laboratory. The degree of accuracy attainable in a volumetric determination of sulphur, however, is largely dependent upon the grade of the iron and the condition under which the test is taken. A method of sampling molten iron which produces a highly chilled test, such as the water shot method, is not desirable, because such a condition in a test piece is conducive to low results when sulphur is determined thereon by the volumetric method. This is due to the fact that, upon dissolution of chilled iron in hydrochloric acid, volatile organic sulphur compounds are formed, which are lost in the process of volumetric determination on account of the inability of the absorbent solutions employed to retain them. The use of such chilled tests makes it necessary to anneal the sample previous to making the determination for sulphur, an operation that lengthens the time of and complicates the determination, and is therefore to be avoided.

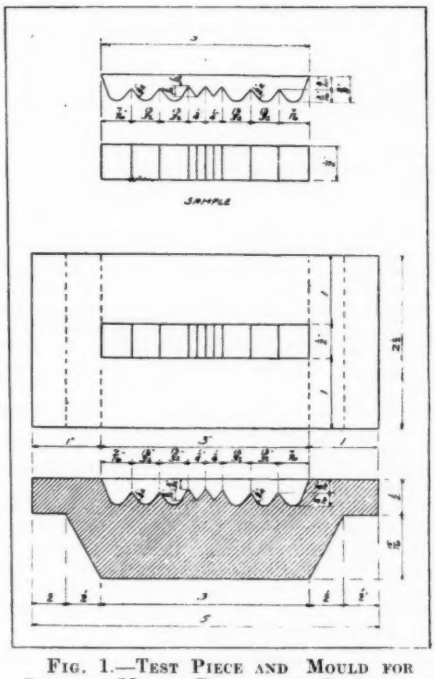


FIG. 1.—TEST PIECE AND MOULD FOR SAMPLING MOLTEN PIG-IRON FOR CHEMICAL ANALYSIS.

Inasmuch as the condition of chill is the predominant influence which causes the formation of non-absorbable gases, it is evident that a successful method for sampling molten iron should yield a test piece which is free from this objectionable condition. The method of casting in sand meets these requirements, and it has been found, moreover, that a sand-cast sample gives an accurate measure of the sulphur content by the volumetric method. However, owing to the danger of contamination from the sand, this sand test is not suitable for the determination of silicon, nor has any method, practical for routine work, been devised for combining sand tests from different parts of a cast into one representative analytical sample.

The methods for sampling which are recommended, viz., the plate test method and the mould test method, do not give tests which are entirely free from chill. However, the rate of cooling is not too rapid, evidently, to prevent certain transformations that take place on slow cooling, for it has been shown by a series of comparative tests by the chemists of the Steel Corporation that there is a very satisfactory agreement in sulphur values as obtained by the evolution method on samples taken by these methods and by the sand-cast method. Therefore, it has been decided to adopt these methods as standard procedure where molten iron is to be sampled.

*Method used and published by the Carnegie Steel Company's Bureau of Information, Pittsburgh, Pa., for the United States Steel Corporation.

SAMPLING OF MOLTEN METAL FROM THE BLAST FURNACE.

Appliances for Sampling.

A spoon, or ladle, and either moulds or an iron plate are employed in taking samples of pig-iron in the molten state. The spoon is similar to or the same as that employed about the furnaces regularly in taking fracture tests.

Description of Moulds and Plates.—Two forms of moulds are recommended, and the use of either is sanctioned. These moulds are made of cast iron, and are illustrated in detail, with dimensions, in Figs. 1 and 2. Both, it will be noted, are designed so that pieces of approximately the same size may be broken from different tests, thus making it convenient to combine individual tests into one representative sample of any body of molten metal.

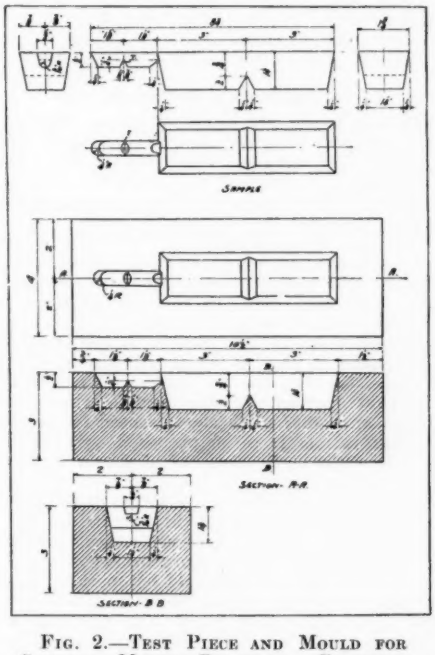


FIG. 2.—TEST PIECE AND MOULD FOR SAMPLING MOLTEN PIG-IRON. COMBINED CHEMICAL AND FRACTURE TEST.

The mould in Fig. 1 gives a test which may be conveniently broken into small pieces suitable for crushing. The number of the furnace may be cast in the mould with Roman numerals, or, if the furnace is designated in another way, some other suitable symbol may be used. The two ridges shown in the test in this figure indicate that the test is taken from furnace No. 2.

The mould in Fig. 2 furnishes a test which may be either drilled or crushed. If the sample is to be crushed, the notched prolongation T is broken and crushed, and the main body of the test is reserved for the furnaceman's fracture test. The furnace number may be cast in this mould, but not so conveniently as the mould described above and only in the main body of the test.

Any iron or steel plate, which has a smooth surface and suitable dimensions, is satisfactory for use in the plate or pat test. As to size, the plate should provide a surface of at least one square foot and should not be less than eight inches in width.

Accuracy and Care in taking the Sample.

The ladle and mould or plate should be clean to insure an uncontaminated sample, and as a safety measure all the sampling appliances should be perfectly dried immediately before using.

Care should be taken to prevent the inclusion of slag or other foreign matter in the sample. This is accomplished as follows:—Avoiding any material that may be floating on the surface of the metal, a full ladle of iron is dipped from the runner and part of it is immediately poured off, whereupon the test is poured by either of the following optional methods.

Plate or Pat Test.—With the spoon resting on the plate, a pat approximately two inches in diameter or larger is poured thereon. Then, changing the resting-place of the spoon, another pat is poured, and these operations are repeated until all the molten metal in the spoon has thus been poured.

Mould Test.—With the spoon resting on the mould, sufficient metal is poured therein to fill the mould. Only one mouldful may be poured from each spoonful of the molten metal.

Number of Samples to be taken.

A representative sample is the basis of reliable chemical analysis. It is a well-established fact that the first iron of a cast may vary greatly from the iron at the end of the cast. In order to obtain a representative sample, therefore, portions are taken from different parts of the cast, and equal quantities from each portion are combined in one lot. It is evident that each portion should represent the same proportion of the whole cast as any other portion. A convenient method is to secure a sample portion, timed as nearly as possible, from the middle of each ladle of iron in the cast.

Preparation of the Sample.

The test pieces are either drilled or crushed as their size and form requires. In the case of pat tests, the cleanest pat from each portion taken from the cast is selected, care being taken to have all these pats of approximately the same size. If desired, the pats are then broken with a hammer and a representative piece, or pieces, is selected from each and combined so that the sample for crushing will contain about the same amount of metal from each pat. In the case of the mould test, the proper proportioning of the sample is much facilitated by the notches in the test piece, which make it easy to break off pieces of about the same size from the test pieces. When crushed, only that portion of the sample which passes through an eighty mesh sieve is used for analysis.

If the sample is to be prepared by drilling, a test piece cast in the test mould shown in Fig. 2, or one of similar form, is used, and the test piece is drilled to a suitable uniform depth from a cleaned area in its top and through its centre. In this case sieving of the drillings is not permissible on account of the larger proportion of graphite present. Also the drill should be operated to give drillings as fine as practicable, else it will be very difficult to mix the drillings from the individual test piece properly to form the sample for analysis.

Sampling from Truck and Stock Pile.

One pig is selected at random from each four tons of iron, and ten pigs, representing forty tons of iron, or an average car load, constitute a sample unit. This proportion will be found convenient for larger or smaller quantities of iron.

Preparation of the Sample.

The surface of each pig is cleaned with a wire brush or by other suitable means to remove all loose sand. The skin is ground from the centre of the top of each pig, exposing clean metal, by means of an emery wheel. Using a ½-in. twist drill, one hole is made in each pig, starting at the centre of the cleaned space and stopping when the point of the drill appears below. To prevent loss of fine particles during drilling, a sheet metal disc is clamped to the cleaned surface of the pig. There should be a hole in the centre of the disc large enough to admit the drill. The drillings are either brushed off as they accumulate or after the drill is withdrawn. The pig is then inverted over a receptacle to collect the drillings that remain in the hole.

The drillings from the entire unit are combined and weighed. They are then sieved, using 80 and 120 mesh sieves with covers. The portions remaining on each sieve and that passing through the 120 mesh are weighed separately and placed in glass-stoppered bottles, which are appropriately labelled. Each portion is well mixed. A proportionate amount is taken from each bottle for the analysis sample, the exact weight of each depending upon the size of the sample desired.

Example.—The gross drillings of a certain sample weigh 500 grammes, and are separated into portions weighing 400 grammes on the 80-mesh sieve, 80 grammes on the 120-mesh sieve, and 20 grammes through the 120-mesh sieve. In this case, a 5-gramme sample consists of 4 grammes from the portion on the 80 mesh, 0.8 gramme from the portion on the 120 mesh, and 0.2 gramme from the portion through the 120 mesh.

Book Review.

MOLYBDENUM ORES.—By R. H. Rastall, Sc.D. Published by Mr. John Murray, Albemarle Street, London, W. Price, 5s. net.

This book has been prepared under the direction of the Mineral Resources Committee of the Imperial Institute, and forms one of their monographs on mineral resources, with special reference to Great Britain.

The section of the book which will interest foundrymen the most is the uses of molybdenum. As is well known, it is incorporated as a special element in both structural and cutting steels. Additionally, it is used as a constituent in acid-resisting steels, magnet steels and stellite. Since the writing of this monograph, Mr. Oliver Smalley has dealt with its incorporation in cast iron, and the tests certainly show some promise of the regular incorporation of the element for definite purposes. In 1918, according to Dr. Rastall, some 800 metric tons of molybdenum was produced. By 1921 this figure had fallen to a world's output of 7 metric tons. Whilst these world productions seem insignificant, it must be remembered that, when translated into terms of molybdenum steel, the 1918 figure, providing it was all absorbed, assumes some importance, and probably represents over 500,000 tons of steel. We notice that the author has employed lbs. per square inch when indicating tensile strengths. As few British metallurgists visualise tests in these terms, we would suggest that in future editions they are converted to tons per square inch. The bibliography forming an appendix to the book is very complete, and will be of the utmost use for future investigators. Whilst the development of molybdenum has mainly taken place during the last decade, which has in every sense been abnormal, it is pleasing to note that the British Empire has commanded a share, ranging from 20 to 70 per cent., of the world's production. It is Canada and Australia which have provided the British quota.

Another New American Foundrymen's Association.

According to the "Iron Age," an organisation meeting of Indiana foundrymen was held at Purdue University, Lafayette, Ind., November 24 and 25, to bring the foundrymen of the State closer together, for discussion of problems affecting the industry. Mr. Arthur J. Tuscany, secretary-manager of the Ohio State Foundrymen's Association, explained the workings of his Association, and it is probable that an Indiana association will be patterned after it. This is the second association to be formed this autumn in the States. The American Foundrymen's Association do not organise any branches as is customary here, and these smaller organisations fulfil a real necessity, as their national association meets but annually.

MR. R. A. MILES, Grosvenor Chambers, 24, Deansgate, Manchester, has been appointed representative for the Stanton Ironworks Company, Limited, for the Manchester district.

Institution of British Foundrymen.

NEWCASTLE BRANCH.

Discussion on Mr. J. D. Nicholson's Paper on Dry Sand Moulding.*

MR. MATTHEWS, after congratulating the author, said he was glad to hear emphasis laid on the inadvisability of putting small patterns in the foundry floor. With regard to the question of ramming, one often saw moulders hitting the pattern with a heavy hammer, and that, of course, was not good for the pattern. He appreciated the remark about the patternmaker's way of concealing important screws, which were certainly true. Boiler stop-valve castings have to withstand great pressure, and sometimes the strain is incalculable, and he quite agreed that chaplets were sometimes used carelessly, and that in such castings they should not be used unless the patternmaker helped by making the cores all in one piece. If possible, the job should be cast with the largest print upwards.

MR. OAKFORD referred to the question as to whether a grate should be placed with the narrow or the broad side down. He thought that one was compelled to use the side which happened to be convenient, according to whether it contained stirrups or not. As far as stirrups were concerned, the narrow side should be down in the top box.

MR. NICHOLSON said that in making a few grates eyes are not always cast in.

MR. FRIER said that he was very pleased to hear Mr. Nicholson's Paper, particularly as he was one of his own boys. The fact of his writing such a Paper showed that he had been really taking an interest in his work and had taken notice of what he had been told, and at the same time it showed that he held opinions of his own. There were several things which Mr. Nicholson had embodied in his Paper which had been well thought out, and he (Mr. Frier) was not ashamed to admit that they had been thought out and adopted without any reference to him. A foreman, no matter how clever a man he is, should never refuse to accept recommendation and advice from his men. He particularly hoped to hear some of the boys say something, because he thought that a lecture like this ought to open ample discussion.

Ash Venting.

MR. JAMES SMITH said that he was glad to hear Mr. Nicholson's Paper, because he had always preached that the practical man was the essential man in the foundry. With reference to the engine stop-valve which was made with brackets, Mr. Nicholson had expressed the opinion that the difficulty of bracket scabbing could be overcome by inserting a few ashes and venting the sand. He agreed that that was possible with a green-sand mould, but not with dry sand. He remembered about 35 years ago, when first marine engine work was transformed from loam to dry sand, there was a great difference of opinion as to how the bottoms of moulds should be made to withstand scabbing. He was speaking of the time when the old-fashioned condenser was used, and, naturally, from his green sand experience, the first thing that the moulder did when he commenced on this work was to put a big cinder bed on the flat bottom about 10 to 15 in. from the face of the mould, and when the bottom was finished he would push in a wire pricker. For some years they had had difficulty with scabs, and one day when he (Mr. Smith) was busy with a condenser he decided not to put a cinder bed underneath it, and when the casting was turned out it was exceptionally clean. The reason was this: When a pricker is pushed right down to the cinder bed the large fires naturally draw the dampness from the ashes right through to the face of the mould. Now they never put in a cinder bed at all, because if the mould had to stand for a time the steam would gather on the face of the mould. To illustrate that point, he said at that time the condenser tops were put on the night before, and when the tops were taken off the next morning he had seen drops of water on the mould. He agreed that a cinder bed could be used with a green-sand mould, but if a dry sand mould is thoroughly dry there would be consistently good results.

MR. NICHOLSON, in answer to Mr. Smith, said that the engine stop-valve which he had dealt with was in a box and not in the floor. The hole which he had mentioned was about 1½ in. dia., and when the metal entered the mould the air rushed to this hole, as it provided an easy exit.

Wire Pricking.

MR. FRIER remarked, with regard to venting, that they had had trouble with the wire pricker, but had abandoned the use of it, and obtained a better face on the bottom of the casting on that account. They never used one now, irrespective of the size of the mould, and a cinder bed was not made unless vents had to be carried through the bottom of the mould.

MR. BRAILSFORD said he wished to draw attention to the placing of a dry-sand mould on bricks, after it had been taken out of the stove. His experience had been that the placing on bricks caused trouble, particularly in the case of a large casting which had been placed on about 12 in. of bricks, and the trouble lay in the fact that it fell through the bottom. He agreed with Mr. Nicholson in the method of bringing air off the mould with the brackets and the hole, and had seen the same method used for very large feet and brackets of condensers where they had a coke bed with a hole from the bed to the joints. In the North there was more trouble with scabbing, owing to insufficient venting, than there was in the Midlands. He, personally, had seen moulders making dry sand jobs for iron, as well as for gunmetal and other alloys, without putting a vent in, declaring that it was not necessary. He (Mr. Brailsford) thought it was quite as necessary for the air to be brought off a dry-sand mould as off a green-sand mould.

MR. NICHOLSON said that a box put on a sand bed drew dampness from the sand.

MR. SMITH said that he failed to see how boxes coming out of the stove would draw dampness, because the steam could be seen coming off as soon as the vents were made.

Methods of Drying.

MR. PAULIN said the author had referred to the question of the moulds not always being dried in stoves, but sometimes being dried in position, especially if the job was bedded in the floor. The methods of drying raised excellent points for discussion. There was, for instance, a method of drying based on the air being forced through the coke fire contained in a closed vessel, and the products of combustion being led through a pipe into the mould. With regard to stove drying, had Mr. Nicholson noticed any difference between drying in front of an open fire by means of fresh air and drying in a closed stove? Had any member had experience of the use of Bunsen burners for drying? The author had touched on the question of ramming hard, and had referred to the fact that the introduction of core oils had robbed young men of a great deal of experience in core-making, but if experience was lost in that particular place it was obtained in other directions. The lecturer had also referred to guides and marks on boxes. Instead of making just one flange and pin, he had seen a method of making a double flange and a loose pin simply slipped right through. He considered that this was a most effective method of correcting the slackness of boxes. The lecturer had referred to the great trouble of hanging parts in top boxes. The application of core oil was well worth consideration, as a lot of hanging parts were eliminated, being replaced by cores.

MR. NICHOLSON replied that the practical man knew that too much claywash was detrimental and would not empty a bucketful over a loose piece of mould. With regard to cores, the coreing out of awkward parts would assist moulders in some

* This Paper was published in our last issue.

cases, yet they would have to be fastened and made rigid in the top parts, and with reference to pins in boxes he said that moulders did not like them because one side of the box might jam and cause trouble.

Scabbing Troubles,

MR. MURRAY asked with reference to the mixture of loam and sand, whether Mr. Nicholson ever had trouble with scabs.

MR. NICHOLSON replied that he never had scabs when using loam mixed with sand on the head valve casting, the reason being that the grates were there and the loam was strong enough to hold itself. Any steam caused through the molten metal was forced to rise through the sand.

MR. SMITH said that if loam was put round the joints and a grate put on, the mould would be dried—therefore, what was the difference between that and a dry sand mould?

MR. NICHOLSON said that he was meaning mixing sand with loam, and "one does not get scabs on joints."

MR. SMITH said that Mr. Nicholson had first spoken about making loam joints to secure a clean lift, and if loam was mixed with sand the loam must be dry.

MR. NICHOLSON replied that the loam was mixed with the milled sand by hand and put on the pattern, not on the joint.

Joining Loam to Sand,

MR. MURRAY explained that what he had meant was that the wet loam would not combine with the sand, and when dry there would be a crack between the loam and the sand unless sprigs were used to keep them together.

MR. FRIER said that if one put milled sand next to the loam they would adhere together, but common floor sand would not.

MR. LILLIE said that they had carried out the method of mixing milled sand with loam in the brassfoundry without difficulty. There was not any need to worry about the mould being on a sand bed after it had been dried in the stove because it would not absorb sufficient moisture from the bed to affect the casting.

MR. NICHOLSON replied that when the box was sitting on a bed steam would rise through the pricker holes to the mould face.

MR. SMITH referred to the venting of moulds. Mr. Brailsford had said that in his opinion there was not sufficient venting done in the North. Was he referring to dry or green sand moulds? If the sand was thoroughly dried it did not need venting, but green sand had to be vented as much as possible. In the foundry he would not allow a vent to be made in sand mould, *if it was dry*, because it was not necessary.

A MEMBER said that he had seen dry sand castings which were badly scabbed.

MR. SMITH suggested that the scabs could not have been caused by lack of venting but through the sand not being dry.

THE MEMBER replied that he would not say that the sand was not dry, but in many cases it was impossible to keep the moulds in the stove until perfectly dry because it would hinder other work; therefore, vents had to be used to get the moulds bone-dry, and he considered that with vents one obtained a better skin on the casting.

MR. LILLIE said that he had never known men to plug risers in a brassfoundry, as they had never found any necessity to do so, whether the mould was dry or not.

MR. SMITH said that he had seen the risers blow off large green sand moulds, the air rushing out necessarily brings down a green sand top. When casting a green sand mould the risers should be kept closed. If it is a large casting, a weight, with a hook to lift it by, should be placed on the risers and then there would be no fear of them blowing off as before.

Another MEMBER said that he thought that a green-sand mould should be vented with a vent-wire, and when the mould was closed the risers should be kept tight because the gases which were generated must leave by these vent wire holes; but if the risers were not kept tight, the air would take the easiest course out and make for the risers and probably blow out the bottom of the mould.

Senior Surtees Medal Not to be Awarded,

MR. YOUNG, in closing the discussion, said that trade had been very bad this year, and consequently a larger number of moulders were without work. Probably 99 per cent. of these men did no serious work, but Mr. Nicholson had written this Paper and had enjoyed doing it. He (Mr. Young) considered that this fact placed great credit on Mr. Nicholson's Paper, as one is naturally not so interested as when actually doing the work. It is remarkable when writing a paper the number of things one does not know and has to look up. Another thing he would like to point out was that Mr. Nicholson had done all his own drawings, which were exceedingly good ones. From all the foundries on Tyneside, Mr. Nicholson was the only senior candidate for the Surtees medal, and therefore no examination would be held and no award given. A vote of thanks to the lecturer was then accorded.

Recovery of Molybdic Acid and Preparation of Ammonium Molybdate Solution from Ammonium Phospho-Molybdate.*

In methods when ammonium molybdate is employed as a precipitant, an economy may be effected by recovery of the molybdic acid from the filtrates. In case recovery is desired, washings from the operation of filtration are not permitted to mix with the filtrate proper, but the latter is transferred to a suitable container, for reservation, before washing of the precipitate is begun.

When a convenient quantity of the filtrate has been accumulated it is heated to boiling, and a solution of commercial sodium phosphate is added. The weight of sodium phosphate in this solution should be 10 times the quantity of 85 per cent. molybdic acid to be recovered, or 33 grammes of sodium phosphate for the equivalent of each 50 c.c. of ammonium molybdate solution treated. The solution is allowed to stand until the precipitate of phosphomolybdate has settled; it is then decanted and the precipitate is transferred to a wide-mouth bottle of 5 litres capacity or larger. These operations are repeated until a sufficient quantity of the yellow precipitate has been collected, when it is washed by decantation with nitric acid (1:50). It is then transferred to a large dish, and the liquid is evaporated. When dry, this precipitate, or a mixture of this precipitate and molybdic acid, is employed for the preparation of ammonium molybdate solution. The recovered phosphomolybdate contains 92 per cent. molybdic acid; hence, when used alone, 60 grammes are sufficient to make one litre of the solution.

Ammonium molybdate solution is prepared from recovered phosphomolybdate as follows: Sixty grammes of the phosphomolybdate are dissolved in 230 c.c. of water and 170 c.c. of AmOH. A solution of 10 grammes of commercial magnesium nitrate or sulphate dissolved in 30 c.c. of water is now added to precipitate the phosphate. The flask is shaken and the precipitate is allowed to settle, whereupon the solution is filtered and the precipitate is washed with 30 c.c. of ammonia (1:4). The filtrate is cautiously added to 540 c.c. of nitric acid (1:1). The solution is now ready for use as needed.

THE MONTHLY ASCERTAINMENT under the sliding scale in operation in Cumberland and North Lancashire shows that the average selling price of Bessemer mixed numbers of hematite pig-iron for November, 1922, was 91s. 9d. per ton, an increase of 1s. 5d. compared with the previous month. Blastfurnacemen's wages on the West Coast accordingly rise by 1 per cent. to 31½ per cent. above standard, and bonus earnings in West Cumberland to 64¼ per cent., and in the Furness district to 59½ per cent. This will take effect as from the commencement of the second full pay in December.

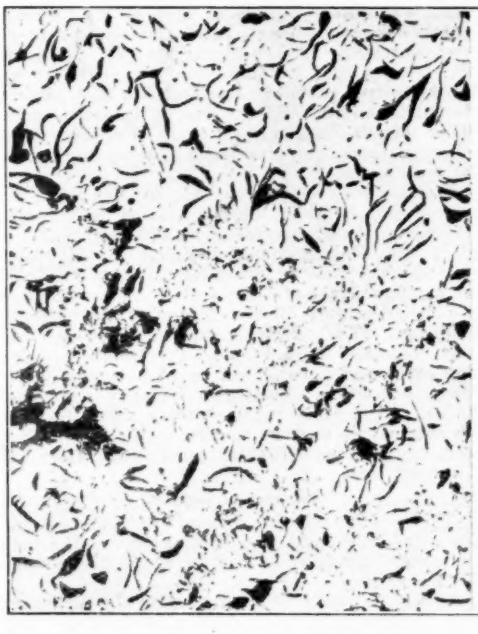
* A method used and published by the United States Steel Corporation.

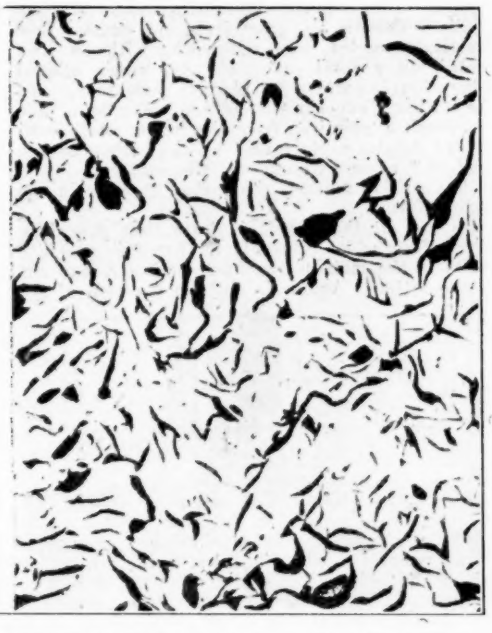
The Effect of Special Elements on Cast-iron.*

By O. Smalley, M.I.Brit.F.

The scope of this paper will be confined chiefly to the carbon problem of cast iron and to present some exploratory experiments on the effect of various special metals, such as Cu, Ni, Cr, Mo, W, etc., on the quantity and form of the graphite and to consider briefly the commercial possibility of direct manufacture of alloy malleable from the cupola.

In ordinary cupola-melted grey cast iron the graphite content varies between 2 and 3.9 per cent. This represents approximately 5.2 to 10.5 per cent. of the total volume of the iron, and being in effect, so far as strength and toughness are concerned, equivalent to so much space distributed as tiny worm-like cavities. It requires no stretch of the imagination to appreciate the far-reaching influence of small variations of graphite on the physical properties, and the importance of accurate control of both the quantity and mode of distribution. Yet it is singular that even to-day these two factors receive but scant consideration and it is not uncommon to find investigations on the effect of special elements published, which do not even consider the carbons present. To some extent this is explained by the fact that the quantity of total carbon, hence the graphite content, is a variable difficult of control and affected in the daily melt by such factors as:—(1) The percentage of total carbon, graphite content, and its physical form in the original pig melted; (2) design of the cupola; (3) quality of coke used; (4) depth of coke bed; (5) proportion of blast to coke; (6) coke to iron ratio; (7) temperature of melting; (8) rate of melting and so on. And being associated as it is with so many other variables, there is some difficulty in taking it into account at all and one recognises the diffidence of any investigator in publishing his results.





FIGS. 1 AND 2.—SHOWING THE MICRO STRUCTURE, MAGNIFIED 50 TIMES, OF CLOSE AND OPEN FRACTURES OF A GREY IRON CASTING.

Physical Form of Graphite.

Recent research proves that graphite in cast iron possesses the same crystalline form and undergoes the same allotropic changes as ordinary mineral graphite. It is usually contaminated with both the gaseous and the solid foreign matter in the iron. According to Moissan it is of the swelling type. Graphite possesses varying degrees of refractoriness and lubricating qualities, according to temperature and other conditions of manufacture. For fuller information reference should be made to the researches of Moissan.

Grading of Pig-iron.

Silicon considered in conjunction with the quantity and form of the graphite is the commonest method of grading pig-iron and controlling the texture of iron castings. Each of the other common elements, Mn, S and P, certainly receive due consideration, but more often from the question of the production of clean sound castings and cost. Sulphur, the *bête noir* of cast iron, figures more prominently in the mode of distribution of the carbon than is generally appreciated, and, under control, is of the highest value as a strengthener and grain-refiner. The average melter, however, is better satisfied in keeping this element on the low side, rather than make use of it.

Mass Effect.

That the rate of cooling during solidification is an important factor controlling the form of the graphite, with which is associated the texture, is generally recognised, but like the sulphur problem, it has been insufficiently investigated, and is therefore not fully understood. There exists, however, for every grade of grey cast iron a certain critical rate of cooling, which yields, within practical limits, the same grain or density, regardless of section or dimension of the casting.

This method of control certainly possesses definite limitations, but it presents an immediate solution to the pig-iron problem. When once the importance of control of the rate of cooling during solidification is fully understood, not one per cent. of present-day troubles arising from open texture and porous patches—defects all too common to large castings and castings of varying sections—will be encountered. The mass effect problem, being beyond the scope of this Paper, cannot be adequately treated here.

Solubility of Carbon in Molten Iron.

It is commonly asserted that graphite is necessarily a decomposition product of the carbide, and does not exist as such in molten iron—a controversial problem which would be all the better for

* A Paper read before the Sheffield Branch of the Institution of British Foundrymen.

airing and closer investigation. In fact, until more information is forthcoming on the nature of the solution of carbon in iron, which will admit of a working theory, one cannot investigate such problems as are mentioned in this Paper, save by laborious, exhaustive, practical experiments. Consider this problem for a moment. If all carbon in molten cast iron exists as carbide, should not a regular rate of cooling deposit graphite in a regular form, instead of yielding irregular masses suggestive of a mechanical deposition? Why, as a general rule, is it found that the higher the casting temperature of grey cast iron, the better the test-results and the closer the grain? It is not a result of the quantity of carbide formed? The author has not been able to associate the combined carbon-content in grey iron with either strength or texture, and there is no general agreement as to the desired combined carbon-content necessary to the highest strength. True alloys do not behave in this way, and, according to the solution theory, molten cast iron is a true alloy. Columnar crystallisation common to solid solutions is practically unknown in grey iron, no matter how drastically cooled, and die-casting with an iron containing a total carbon-content under alleged saturation is quite a commercial possibility. In the author's experiments he has never been able to quench a grey iron from the molten state sufficiently drastic as to retain all the carbon in the combined state. Recent metallographic research of the carbide suggests the carbon to exist in the atomic form.

Do not all these facts indicate that grey iron differs from white iron only in that free graphite exists in the molten iron in the former, but not in the latter? Again, is not the question of the

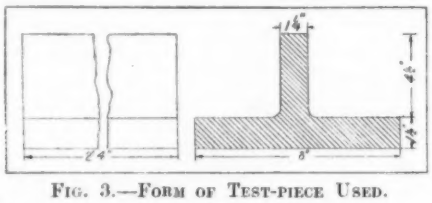


FIG. 3.—FORM OF TEST-PIECE USED.

solubility of graphite in cupola-melted grey iron closely connected with the form and quantity of the graphite in the pig melted? If a coarse-grained graphitic iron is melted, the castings are neither as strong nor as tough as those obtained from close-grained irons of the same chemical composition. Is it not that coarsely-disposed graphite in pig iron may not completely dissolve in ordinary cupola-melted iron, but retains a ghost-like outline of its original form in the molten iron, and so reproducing the original coarse structure of the pig in the finished casting by this free graphite acting as nucleus for the deposition of more free graphite during solidification—a view the author expressed in a Paper* read to the Newcastle Branch?

Briefly and simply stated, do not the foregoing facts justify the suggestion that graphite is merely mechanically suspended in molten grey iron, and the colloidal theory present a working foundation for the study of the effect of special elements considering each quantitatively, either as a coagulating or peptising agent? Does not this theory also present a working foundation from which one may systematically investigate the problem of manufacture direct of cupola malleable?

Grain Refining Experiments.

Foreign Matter.—Figs. 1 and 2 show the microstructure of a close and open fracture from the same section of a casting. The explanation of the difference in grain is seen to lie in the different form of the graphite flakes. In Fig. 1 the presence of excess sulphide of manganese is evident, and in Fig. 2 it is absent, suggesting that each particle of insoluble sulphide functions as a centre for the deposition of graphite; hence the bunch effect shown.

Effect of Special Elements.

Carrying this reasoning further, is it not logical to suppose that the introduction of some higher melting-point constituent of about the same density, distributed uniformly in a fine state of division, would be equally effective in reducing the dimensions of the graphite flakes throughout the mass in the same way? Such a method certainly presents practical difficulties; oxides, silicates, sulphides may function in this way, but, apart from difficulties due to segregation, they are objectionable on other grounds. With the exception of Cu., all base metals worthy of consideration combine with C. and dissolve readily in molten cast iron.

Pure iron, alloying with Cu. and giving rise to a high melting-point constituent containing about 8 per cent. Cu. of approximately the same density as molten cast iron, suggested itself worthy of trial if it were introduced in the ladle and not in the cupola.

To test the practicability of this, and also to investigate the relative grain-refining effect of other special elements, it was decided to cast a series of test bars, of the form shown by Fig. 3, from an ordinary grade of iron of the following chemical composition:—Total Carbon, 3.2 to 3.6 per cent.; Si., 2.0 per cent.; Mn., 0.7 per cent.; P., 0.8 per cent.; and S., 0.10 per cent. It was made from 6 parts of Cleveland No. 3, 5 parts of hematite mixed, and 8 parts of hematite scrap. This mixture has a good fluid life, and yields clean castings, but is objectionable on the ground of open grain.

Six moulds were prepared in dry sand and placed side by side, the temperature at the time of casting being controlled at 100 deg. Fah. (37 deg. C.). Thirty hundredweights of this metal was tapped from an 8-ton cupola into one ladle, at a temperature of 1,380 deg. C. From this, six 3-cwt. ladles were filled, introducing the necessary additions. The pouring temperature of each cast was controlled at 1,300 deg. C. Details concerning each special metal will be given under its distinctive heading. Each experiment was repeated twice, and in some instances three times, in order to obtain true average results, sectioning the bars through the centre for structural examination and hardness tests.

Influence of Copper.

This was introduced by means of a 20 per cent. Fe. (Cu.-Fe.) stock-alloy in stick form. The ladle was well stirred, and stood for about five minutes before casting.

Prints 1 and 2 (Fig. 4) depict the structural change wrought by the addition of 0.5 Cu. This confirms the anticipated results.

Under the microscope no special constituent could be traced, despite the non-alloying properties of Cu. with cast iron, although this does not prove its absence. It will be observed that accompanying the introduction of small quantities of copper there is a slight increase of Brinell hardness, although the tendency for the combined carbon-content is to fall.

Influence of Nickel.

Nickel alloys with iron in all proportions, but reduces the solubility for C. and renders the carbide somewhat unstable, *i.e.*, it facilitates the conversion of carbon from the combined to the free state. Bauer and Piwowarsky* showed, however, that up to 1½ per cent. of Ni. is beneficial in cast iron, increasing the transverse strength 30 per cent. without affecting the deflection, raising the compressive strength 30 per cent., the tensile strength 25 per cent., and the hardness 18 per cent. Quantities above this cause segregation of the graphite, which more than counter-balances any toughening or refining action that it may have on the ferrite grain and on the form of the pearlite. Witman† made use of this fact by introducing 5 per cent. Ni. into cast iron for the manufacture of electric resistance grids of small section, which must be soft, show an open grey fracture, be resistant to shock and stand up well under rough usage. He claimed that an alloy of the following composition met all these requirements:—TC, 3.6 to 4.0 per cent.; Si, 2.4 to 2.6 per cent.; S, under 0.05 per cent.; P, under 0.08 per cent.; Mn, under 0.46 per cent.; Ni, 4 to 5 per cent.; Cu, 0.5 to 0.7 per cent., and that the casting

* FOUNDRY TRADE JOURNAL, May 4, 1922.

* Stahl und Eisen, September 30, 1920.
† A.I.M.M.E., August, 1921.

may be twisted cold into various shapes, taking a permanent set before breaking.

Print No. 3 (Fig. 4) shows the densening effect of 0.50 per cent. Ni on the structure of ordinary grey iron. This was cast under the same conditions as the copper alloy, introducing the Ni into the ladle in the form of shot, and allowing to stand 4 min. after well stirring. Microscopical examination confirmed the macro-etching, and showed the change to be one of dimension of the graphite flake, there being little or no combined carbon present. According to the Brinell figures, this quantity of Ni has little or no effect on the hardness.

Influence of Chromium.

Little systematic investigation has been conducted on the effect of Cr on cast iron. It is well known that Cr exists in a state of solid solution in pure iron. In steel it gives rise to a double carbide of Cr and Fe—$(Fe_3C)\ x\ (Cr_3C_2)y$—which varies according to the Cr content. As the Cr rises the proportion of Fe_3C falls, and it is thought that in the presence of over 5 per cent. Cr a third carbide forms Cr_4C, eventually replacing the Cr_3C_2. Cr, in contradistinction to Ni, thus increases the solubility for carbon, and opposes the dissociation of the carbide into its component parts, and for which reason is an effective hardener. Klep concludes from a brief investigation that very little benefit accrues from the addition of Cr. Campion* has shown that 1 per cent. Cr slightly increases the tensile strength and transverse strength without affecting the hardness. He has also shown that this quantity of Cr increases the combined carbon-content from 0.831 to 1.094 per cent.

* B.F.A., 1918.

In the present exploratory grain-refining experiments, 0.5 per cent. of Cr was introduced by means of a molten 65 per cent. Cr, ferro-chromium alloy. This was well stirred, and the ladle of metal allowed to stand 4 min. before casting.

Etching No. 4 (Fig. 4) shows that this quantity not only closes the grain, but improves solidity and increases the hardness throughout, the centre of the thickest section having the Brinell hardness and solidity of that of the thinnest section of the same iron without Cr. This, together with other preliminary experiments with Cr, were very promising and considered in conjunction with its remarkable value in steel in improving wear, imparting great strength at high temperatures, eliminating oxidation at high temperatures and its invaluable rust-resisting properties, a more detailed investigation of the effect of varying quantities of Cr on ordinary cast iron was considered worth while, and the results are included in a separate Paper.

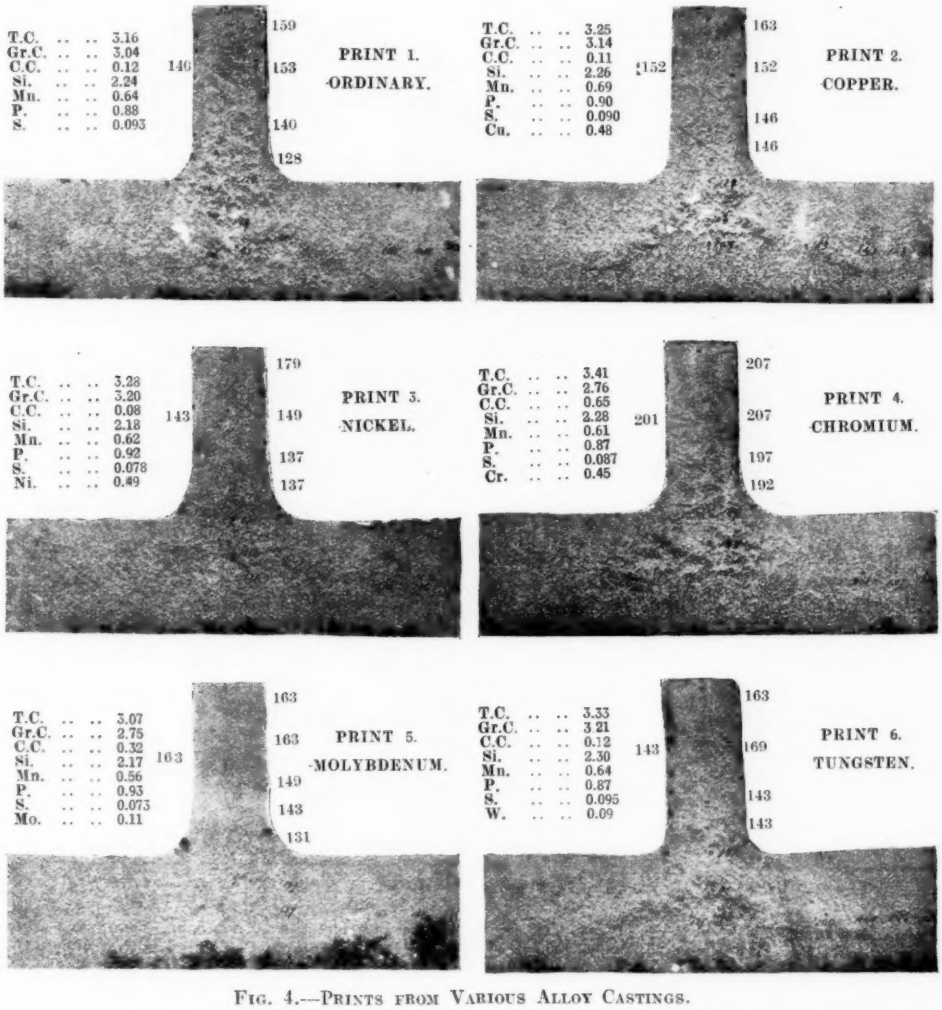


FIG. 4.—PRINTS FROM VARIOUS ALLOY CASTINGS.

Effect of Molybdenum.

Mo, like Cr, is of proved value in steel, but little is known of its effect on cast iron. In steel it combines preferentially with the ferrite, and forms a solid solution of Mo and Fe, although it combines with the carbon, forming a double carbide of Fe and Mo, which fairly readily dissociates. This points to the fact that Mo might play the dual rôle of both Ni and Cr, and results of such exploratory tests as had been made were keenly anticipated.

In the grain-refining experiments under discussion 0.10 per cent. Mo was introduced by means of molten 8 per cent. Mo, ferro-molybdenum, well stirring, and then allowing the ladle to stand 4 min. before casting.

Etching No. 5 (Fig. 4) shows this percentage of Mo to have closed the grain without appreciably affecting the hardness.

Fig. 5 shows a fracture of this Mo iron, together with the ordinary grey iron, for purpose of comparison. Campion,* working with a somewhat harder iron, showed 1 per cent. Mo to increase the strength and reduce the hardness.†

Influence of Tungsten.

Prof. Campion‡ reviews the work of past investigators on the effect of W on cast iron, and publishes some experiments which show 1 per cent. W, increases the strength, but reduces the Brinell hardness.

The brief exploratory tests which the author has made in this field of research, by introducing 0.10 to 1.0 per cent., did not reveal features sufficiently outstanding to justify exhaustive investigation.

Etching No. 6 (Fig. 4) shows the effect of 0.10 per cent. W on the grain of ordinary grey iron.

The W was introduced by means of a 3 per cent. W ferro-tungsten alloy, in the molten state, the other conditions being similar to those outlined in the Mo experiments. In many respects it behaved like Mo, with the exception that the section was by no means so uniformly solid throughout, although it was an improvement on the ordinary iron (etching No. 1, Fig. 4).

As far as hardness is concerned, 0.1 per cent. W, similar to a like quantity of Mo, exerts little influence.

Conclusions.

These experiments, whilst only exploratory, briefly demonstrate the relative values of various special elements as deseners of common soft grey cast iron, and suggest that the introduction of small quantities of Cu, Ni, Cr and Mo are efficacious in helping to eliminate coarseness of texture and sponginess.

DIRECT MALLEABLE CAST-IRON.

At some time or other most foundrymen have turned their attention to the problem of the manufacture of malleable cast iron direct from the cupola. It is a problem of engaging fascination, and it is proposed to consider briefly the possibilities of development by the introduction of special elements.

Possibility of Copper.

Very little information has been published on the effect of Cu in any quantity on cast iron. Being a ductile metal, and having no chemical affinity for carbon, Cu naturally suggests itself worthy of consideration. For the present investigation a hematitie pig-iron of the following chemical composition was chosen:—TC, 3.3 per cent.; Si, 2.0 per cent.; Mn, 0.70 per cent.; P, 0.08 per cent.; and S, 0.03 per cent. Electrolytic Cu was used, the melting being performed in a crucible furnace, using 5 lb. of iron and adding 5, 10 and 25 per cent. Cu respectively. Each was well stirred and cast in bars 6 in. × 2 in. × ½ in. in dry-sand moulds.

Bending tests on the 5, 15 and 25 per cent. copper alloys gave 0.10, 1.0 and nil degs. respectively, whilst the fracture of the 5 per cent. alloy was grey; the 10 per cent., fine grey; and the 25 per cent., fine grey speckled with yellow.

Microscopical Examination.—In the 5 per cent. alloy the copper was shown to be well distributed, and the graphite was present in fine flakes. So, too, in the 10 per cent. alloy, the copper was uniformly distributed, but the graphite was in nodules and small flakes. In the 25 per cent. copper alloy the copper was distributed in coarse patches, suggestive of segregation, and the graphite was nodular, with only traces of flakes.

No good purpose to be gained by exceeding 10 per cent. Cu. Above this amount the alloy is distinctly sluggish, and the Cu-rich constituent inclined to segregate. There is, however, no doubt that 5 to 10 per cent. Cu serves a useful purpose in reducing the total carbon content, breaking up the flakes of graphite and imparting toughness.

Prospects of Aluminium.

In some preliminary experiments small percentages of this metal were found to reduce the quantity of combined carbon, and to increase the graphite content. Rhead suggests that Al is

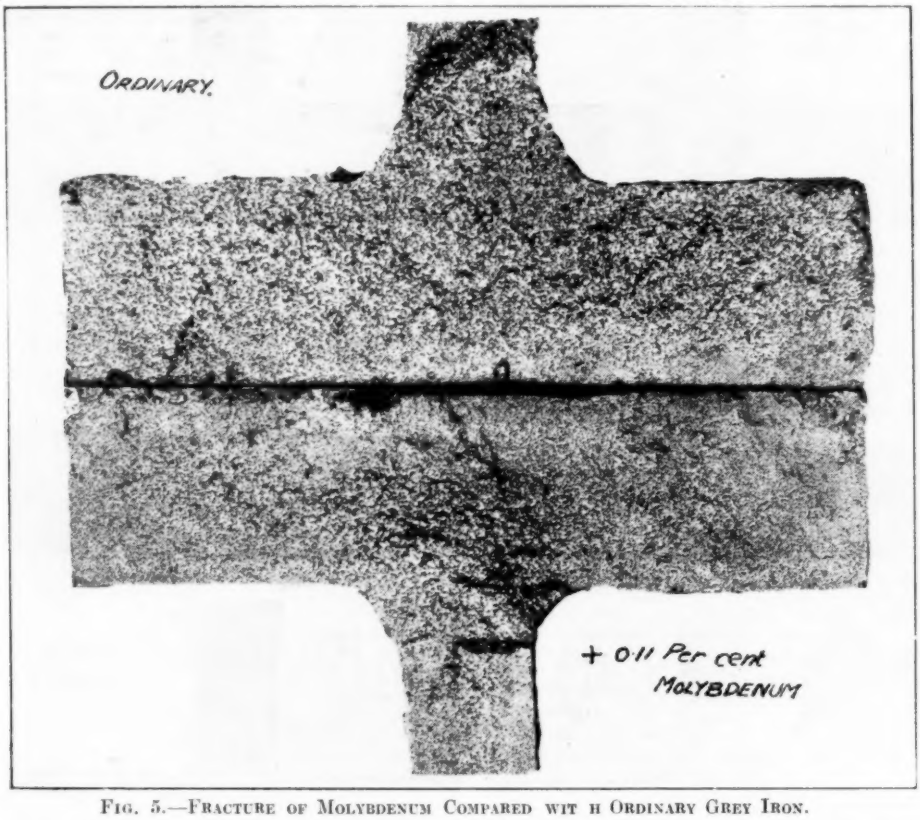


FIG. 5.—FRACTURE OF MOLYBDENUM COMPARED WIT H ORDINARY GREY IRON.

* B.F.A. Proceedings, 1919.
† Subsequent experiments with this element have been sufficiently interesting and promising to justify a closer investigation.
‡ Proceedings, British Foundrymen's Association, 1917–1918, pp. 85–86.

responsible for depositing the graphite in a finer state of division. In the present research two casts of hematite were prepared, introducing 3 and 6 per cent. Al respectively. The 3 per cent. alloy gave no bending angle. It possessed a fine grey fracture, whilst the microscopical examination showed the Gr. to be in a fine state of division, and a white hard constituent was present, distributed in dendrific form. The 6 per cent. alloy was dead brittle, and had a glazed fracture. No Gr was present, the microscopical structure being not unlike that of a badly-annealed steel casting. The Brinell numbers were 277 and 489 respectively. The 6 per cent. alloy was annealed at 870 deg. C. over various periods of time, but the most drastic annealing failed to produce any graphite. The alloy, however, was unaffected by oxidation, and has since been found to possess remarkable non-scaling and non-rusting properties.

Nickel Experiments.

Two casts were made introducing 5 and 7 per cent. Ni by means of shot nickel. The former, on bending, broke at 0.10 deg., giving a fine grey fracture. The microscopical examination revealed coarse flakes of Gr and a Ni-austenitic solid solution. With 7 per cent. nickel, 1.5 deg. were shown on bending. The fracture was of a mottled character. Under the microscope the Gr was finer than the 5 per cent. alloy, and a larger quantity of the Ni-austenitic matrix was present. No improvement in the bending angle was obtained by long annealing either alloys.

Ni and Cu Combined.

From the experiments so far conducted Ni and Cu were the only two metals suggesting themselves worthy of development.

For this further investigation a series of irons with various combinations of Ni and Cu were prepared. The two most promising were a 7 per cent. Ni-3 per cent. Cu and a 10 per cent. Ni-10 per cent. Cu, introducing them by means of a Ni-Cu stock alloy. The former alloy bent 3 deg. before breaking, and the latter 7 deg. Their fractures were "fine grey edges inclined to be silky" and "very fine grey silky edges" respectively. Examined under the miscroscope, the 7 Ni-3 Cu alloy was shown to have the Gr in nodular form and a Cu-rich compound, finely distributed in a Ni-austenitic matrix, was also apparent. The 10 Ni-10 Cu alloy, however, showed only a little nodular Gr, but there was present a free Cu-Ni compound, evenly distributed. Neither was improved by annealing.

Further experiments with Cr and Al additions in conjunction with Ni and a varying Si content were conducted, but with no promise.

The foregoing investigation, although brief, goes far to indicate the difficulties confronting the development of alloy malleable, and leads one to believe that, even if produced in the cupola on these lines, their commercial value will be severely restricted by the cost of the special metals necessary.

Tentative Specification for Tool Steel.—A tentative specification for carbon tool steel has been proposed by the American Society for testing materials. It requires that the steel shall be made by either or both the crucible and electric processes, with the exception of class *C*, which may also be made by open-hearth methods. The steel shall conform to the following chemical composition, carbon varying and the following maxima:—

	Class *A* per cent.	Class *B* per cent.	Class *C* per cent.
Manganese ...	0.400	0.450	0.600
Phosphorus .	0.020	0.025	0.035
Sulphur	0.025	0.035	0.040
Silicon	0.350	0.350	0.250

The carbon percentage shall be as ordered, the specifications varying by ranges of 0.1 per cent., with rejection limits plus or minus 0.025 per cent. The permissible variations in the size of the material ordered shall be determined by agreement between contractor and purchaser. The material shall be free from injurious defects and have a workmanlike finish. The analysis shall be made in accordance with methods for testing carbon tool steel contained in the Book of the American Society for Testing Materials, Standards of 1921.

Blue Constituent in Manganese-Bronze.

In a Paper which MR. E. H. DIX presented to the American Institution of Mining and Metallurgical Engineers the following conclusions have been drawn by the author:—

1. When the hardening elements (aluminium, tin, iron and manganese) are added to the 60-40 copper-zinc alloy in sufficient quantities to produce a high-strength manganese bronze, a third constituent appears in the alphabeta prime complex which has a characteristic clear blue colour.

2. The occurrence of this constituent in reasonable amounts is not necessarily accompanied by brittleness.

3. Annealing for 7¾ hours at 845 deg. C., followed by either water quenching or slow cooling, does not cause the disappearance of this constituent.

4. This constituent, when examined unetched, appears to be of a deeper blue than either the delta constituent of the copper-tin series or the gamma constituent of the copper-zinc series. When etched with NH_4OH plus H_2O_2, the blue constituent is unattacked except for a slight eating away at the edges under prolonged etching, whereas the gamma constituent with the same reagent is immediately tarnished and rapidly dissolved. The characteristic shape of the blue constituent is decidedly different from that of the delta of the copper-tin alloys.

5. For practical purposes in the study of the microstructure of manganese bronzes, it seems highly desirable to regard the blue constituent as distinct from either the delta or gamma, and it is suggested that it may reasonably be denoted as delta prime.

6. In the manufacture of manganese bronze the particles of delta prime are precipitated from the copper-rich solution by the addition of the zinc. This precipitation is strongly influenced by the presence of iron and, therefore, the particles probably consist of a solid solution of iron and copper with or without some tin, aluminium or manganese.

New Installations of Electric Brass-Melting Furnaces.

According to the "Iron Age," the Detroit Electric Furnace Company, Detroit, has arranged to supply a 2,000-lb., 300-kva. Detroit electric brass melting furnace for the Ford Motor Company at Highland Park, Mich. This furnace, when installed, will complete a battery of eight 2,000-lb. furnaces in the brass foundry of the company. These furnaces are expected to handle the entire brass melting requirements of the Ford organisation. The Detroit company is also installing a battery of three furnaces in the plant of the Neptune Meter Company, Long Island City, N.Y., which manufactures water meters.

Other installations now being made by the Detroit Electric Furnace Company are one 2,000-lb. furnace in the plant of the Tottenville Copper Company, Staten Island, N.Y., and one 500-lb. furnace in the United States Arsenal, Watertown, Mass. With the exception of the furnace at the Watertown Arsenal, all of the installations above mentioned are equipped with automatic electrode control, thus to eliminate the necessity of an operator in attendance at the furnace.

The British non-ferrous industry is making but slow progress with the electric furnace, due to the high cost of electricity.

THE OUTPUT of marine machinery for the year 1922, by Richardsons, Westgarth & Company, Limited, Hartlepool, Middlesbrough and Sunderland, aggregated 36,640 i.h.p. In addition Messrs. Richardsons, Westgarth have manufactured during the year considerable land plant with contraflo kinetic high vacuum condensing installations, including two surface condensers of 40,000 square feet each; also Nesdrum water tube boilers, steel works plant, etc.

Trade Talk.

EXTRAS on solid-draw brass and copper tubes have now been reduced by about 50 per cent.

MR. G. E. SAWYER, engineer, has removed from 35, to 41, Whittall Street, Birmingham.

THE IMPORTS of foreign iron ore at the Senhouse Dock at Maryport last week amounted to 3,500 tons.

MR. J. M. DURIE has established himself in business as an electrical engineer at 21, Victoria Road, North Berwick.

BRUCE, PEEBLES & COMPANY, LIMITED, engineers, Edinburgh, state that their works will be closed from Friday, December 29, until Monday, January 8.

PETTIGREW & MERRIMAN, LIMITED, electrical engineers, of 122, Tooley Street, London, S.E.1, are establishing a branch at 54, Gracechurch Street, E.C.3.

THE LEWIS SPRING COMPANY, LIMITED, Redditch, have appointed Lionel Robinson & Company, 3, Staple Inn, Holborn, W.C.1, sole agents for the electrical trade for their productions.

THE Admiralty have this week placed a further contract with Joseph Kaye & Sons, Limited, of 93, High Holborn, London, W.C., and Lock Works, Leeds, for their patent seamless serrated steel oilcans.

THE LONDON ELECTRIC FIRM, of Croydon, have acquired from Henry Williams, Limited, Darlington, the branch of their business recently carried on under the style of the Arc Lamp Lowering Gear Company.

NATIONAL ALLOYS, LIMITED, Altior Works, Ilford, Essex, have appointed Mr. Robert Bell, of 73, Drury Buildings, Water Street, Liverpool, as their representative for Liverpool and the North-West of England.

THE MIDDLESBROUGH AND DISTRICT ASSOCIATION OF FOREMEN ENGINEERS AND CHIEF DRAUGHTSMEN held its annual meeting on Saturday last, when Mr. C. T. S. Arnett read an instructive paper on "Electricity as Applied to Steelworks."

THE ENTERPRISE MANUFACTURING COMPANY, LIMITED, of Electric House, Grape Street, Shaftesbury Avenue, London, W.C.2, have been appointed London and export agents for the Imperial Engineering Company, 56, Darlington Street, Wolverhampton.

W. G. BAGNALL & COMPANY, LIMITED, Stafford, have received an order for nearly a quarter of a million steel railway sleepers for the Indian Government. The firm have also in hand the construction of three locomotives for a foreign Government.

THE TWELVE MONTHS' output of new tonnage by Workman, Clark & Company, Limited, Belfast, totalled 51,095 gross tons, a reduction of 2,543 tons as compared with the previous years. The numbers of vessels launched totalled six and nine respectively.

BEFORE THE MEMBERS of the Sheffield Society of Engineers and Metallurgists, at the Applied Science Department of the University of Sheffield, on December 11, Dr. W. Rosenhain, of the National Physical Laboratory, delivered a lecture on "The Hardening of Metals."

NECOL INDUSTRIAL COLLODIONS, LIMITED, the manufacturers of Plastic wood, have, owing to the necessity for their being nearer the parent concern—Nobel Industries, Limited—at Nobel House, taken new offices at Windsor House, Victoria Street, Westminster S.W.1, to which address all letters should be sent.

THE business of Trevelyan & Company, of 155, Bracebridge Street, and C. H. Davies & Company, Limited, 153, Bracebridge Street, Birmingham, have been amalgamated, and will in future be carried on under the style of Trevelyan (Birmingham), Limited. Mr. T. Gladdy and Mr. T. Reynolds are directors of the company.

SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED, propose to build at the Wallsend yard three vessels of about 2,500 tons each, on their own account, and suitable for service on the Canadian lakes. The company are also building a collier of about 2,600 tons d.w. capacity on speculation, besides another one which is on order for a Newcastle firm.

THE DIRECTORS of the Ropner Shipbuilding & Repairing Company, Limited, Stockton, propose to reduce the capital from £400,000 to £200,000 by returning one-half of the amount paid up on the present shares, and by exchanging shares in the reconstructed company for the remainder. There will be no change in the directorate or management.

CHINA'S NEW TARIFF SCHEDULE, which was drafted by an International Commission in session in Shanghai for six months, and is designed to fix an effective 5 per cent. *ad valorem* tariff, came into effect on December 1, with the proviso that all goods consigned to China, shipped and en route before December 1, shall be permitted to enter the country under the old tariff schedule.

THE GLASGOW TRAMWAYS COMMITTEE has approved of a recommendation to accept the tender by the Cargo Fleet Iron Company, Limited, Middlesbrough, for the supply of 4,200 tons of steel rails, with the necessary fish-plates, at an approximate cost of £41,000. An offer by a German firm, which was £5,000 lower, and one by a Belgian firm £4,000 lower were refused.

THE BIRMINGHAM METALLURGICAL SOCIETY'S annual dinner was held at the Queen's Hotel on December 16, the President (Mr. A. J. G. Smout) being in the chair. During the proceedings presentation was made of the society's silver medal to the following past-presidents: Mr. J. H. Stansbie, Professor T. Turner, Mr. I. E. Lester, Mr. F. C. A. H. Lantsberry and Mr. A. Spittle.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, of London and Darlaston, have secured contracts from Robert Heath & Low Moor, Limited, for open hearth steel plant consisting of the following:—Two open hearth steel furnaces complete with charging platforms, Wellman mechanical gas producers, 80-ton ladle crane; open hearth charging machine, magnet crane, etc.

IT IS OFFICIALLY ANNOUNCED by the Admiralty that the hull of one of the new battleships will be built on the Tyne by Sir W. G. Armstrong, Whitworth & Company, Limited. The engines and boilers are to be made on the Tyne by the Wallsend Slipway & Engineering Company, Limited. The hull and machinery of the second battleship are to be built on the Mersey by Cammell, Laird & Company, Limited. The armour for both ships will be manufactured at Sheffield, Manchester and Glasgow. The guns will be made at Newcastle-on-Tyne, Sheffield, Barrow, Manchester, Glasgow, Darlington and Woolwich. The gun mountings will be made at Barrow and Newcastle-on-Tyne.

AT A MEETING of the members of the Staffordshire Iron and Steel Institute, at the Education Offices, St. James's Road, Dudley, on December 16, Mr. Harold Harris gave an interesting paper on "Native Methods of Making Iron in India." *Inter alia*, the speaker gave an account of the processes of manufacture as carried out on the Rajdoha Copper Mining Company's property, Rajdoha, Singhblum, Chota Nagpur, Bengal, at the time of his connection with the company, together with the research work done during the past year on the actual iron made at Rajdoha. Dr. Percy, he said, in his "Metallurgy of Iron and Steel," published in 1864, gave an excellent description of the methods and furnaces employed in India, and there had been practically no alteration in the manufacture since he described it. Following the paper, which was illustrated with lantern slides, there was an interesting discussion.

Publications Received.

THE SHEEPBRIDGE COAL AND IRON COMPANY, LIMITED, CHESTERFIELD.—A well-illustrated booklet outlining their productions. It is of special interest for foundrymen, as it contains many pictures of the largest types of engineering castings.

Patent Abstracts.

Particulars of Complete Specifications accepted, furnished by Mr. Eric Potter, Patent Agent, 27, Chancery Lane, W.C.2, and Commerce Chambers, Parliament Street, Nottingham.

Printed copies of the specifications in the following list will be on sale December 28, 1922.

COLELLA, F. E. Mould for casting hollow metal articles. 189,513.

FEROLITE, LIMITED, AND CLAPP, H. B. Crucibles, retorts and the like. 189,692.

BELLIS HEAT TREATING COMPANY. Crucibles. 168,887.

Societe Lorraine Miniere et Metallurgique.—This French concern reports for the financial year 1921-22 profits amounting to 535,000 fcs. (£8,230). There is to be no dividend, but the available balance is to be carried forward. The company's share capital is 50,000,000 fcs.

Schneider et Cie (Le Creusot).—This French concern reports for the year ended April 30 last, profits aggregating 11,315,423 fcs. (say, £174,100), as compared with 13,336,412 fcs. in the preceding year. A dividend of 100 fcs. per 300 fc. share is recommended, as compared with 120 fcs. (33⅓ per cent.) in the previous year. The share capital stands at 36,000,000 fcs.

IRON AND STEEL MARKETS.

Pig-iron.

Movements in the various pig-iron markets disclose few features of importance in view of the holidays now impending, business on any scale of magnitude being practically suspended until the New Year, while deliveries going forward for the next few weeks will be generally confined to requirements of an urgent character. It is, however, satisfactory to note that the outlook for the trade is far more favourable at the present time than it has been during the past twelve months, the expansion of home demand continuing progressively steady, while on the export side the total tonnage for the six months in succession records an increase. During November we exported 383,998 tons of iron and steel, including scrap. The average monthly tonnage in 1913 was 423,858 tons, so that the November figure is barely 10 per cent. down from the average for what was a record pre-war year. This is reassuring, and indicates that a definite improvement has set in. In the South Staffordshire area, quotations for all qualities of pig are firmly held, any anticipation that the reduction of rail transport charges would lead to a similar movement as regards makers' prices, having been disappointed. Already an additional 1s. is being asked for some makes of Northamptonshire forge iron, and undoubtedly there is a better demand for that quality as the output of the finished-iron works improves, while in the case of one Derbyshire firm at least forge quotations have been withdrawn. It has not yet been found possible to restart the idle furnaces in South Staffordshire and Northamptonshire, and it is not thought that the lower railway rates will be sufficent to bring them into operation again. Conditions in the Scottish industry are a little more promising, buyers recently having been taking increased interest in pig-iron, especally on forward account, some parcels for delivery early next year having been placed in the Glasgow market. With regard to foreign business 1,000 tons of Scotch iron was sold recently for the United States, whilst the inquiry from other markets is slightly better. The shipments abroad from the Clyde last week were 1,624 tons, as compared with 75 tons for the same week last year. In Lancashire, markets also disclose a firmer tendency, sellers of foundry iron making efforts to obtain little better prices, and in the case of small parcels, with some success. Competition is also in course of renewal between Northamptonshire and Derbyshire smelters, from which foundry iron consumers should gain some advantage. Business on Tees-side is just now subject to holiday influences, but the improvement in shipbuilding has encouraged some orders from makers of marine castings, who have purchased fair quantities of pig-iron for delivery over the first quarter of next year. Export trade continues to be almost negligible. In these circumstances stocks have of late tended to expand, and prices are accordingly showing a somewhat weaker tendency. No. 1 and silicious are 2s. 6d. below the peak at 95s., and No. 3 G.M.B. can be done at 91s., though prices are irregular, some makers holding out for 92s. No. 4 foundry is obtainable at about 85s., and No. 4 forge at 82s. 6d.

A brisk business is passing at Middlesbrough in hematite pig-iron. Makers are very fully sold over the next four or five weeks, and are already in a fairly satisfactonry position for the whole of the first quarter of the New Year. While the home trade has thus shown considerable improvement, export business is still on a restricted scale owing to currency difficulties. There is, also, keen competition from French sources. Prices are firmly held at last week's levels. For East Coast mixed numbers 93s. is an average figure, and the premium for the No. 1 quality varies from 6d. to 1s. per ton. Production of West Coast hematite is now hardly equal to demand, although an additional furnace has been put into blast at Barrow, while another furnace may be lighted in West Cumberland immediately, but this, it is stated, will be used for increasing the make of low-phosphorus iron, the call for which comes in the main from users in the Midlands. Prices are firm, Bessemer mixed numbers being quoted at £5 5s. to £5 10s. per ton delivered at Glasgow and Sheffield.

Finished Iron.

Though still less buoyant than other sections of the iron industry, the outlook in the finished material branch is certainly more promising in the direction of increased activity in the near future, consequent, perhaps, upon recent developments in the shipbuilding and engineering industries, both being important consuming interests in this market. The chief obstacles to progress in the finished iron trade at the moment, are, of course, the high costs of production, and the active competition of foreign makers, against which home manufacturers are almost hopelessly handicapped. The latter conditions have an adverse effect, especially as concerns makers of secondary grade iron, who are mainly subject to the Continental invasion of our markets, manufacturers of the higher qualities of marked bars owing their immunity from competition to the prestige the best-known brands enjoy in the world's markets. Consequently the firms having an established reputation in the trade are finding it a little less difficult to obtain orders, and the problem of carrying on is not so acute as it was. Current prices have not improved to any appreciable extent, and business is still insufficiently remunerative, but the experience of the last few weeks has induced a more optimistic impression. Gas strip continues quiet, owing entirely to the unfavourable comparison of its price with that for steel strip.

Steel.

The steady improvement recently reported in the steel trade continues unabated, the heavy branches of the industry, especially firms interested in railway requirements, having been largely advantaged by development schemes now being pressed forward to alleviate unemployment. The placing of war ship contracts also will undoubtedly make the improvement much more general, for business admittedly makes business. Some good orders have been placed in this country from Spain for mill work and the like, which will keep the makers busy for a considerable period. Dealing more specifically with ferro-alloys, there has been of late a fair demand for ferro-silicon and prices remain very firm, particularly for 45 per cent. grade. All makers' prices are advanced, while several makers are going out of business until prices are better. On the other hand, silico-manganese is quieter, and there is plenty offering at round about £16 10s. per ton, for 50/55 per cent. Mn., and 20/25 per cent. Si. content, while silico-spiegel with 8/10 per cent. Mn. and 10/12 per cent. Si. can be had at about £10 10s. per ton delivered, according to quantity involved. At Sheffield there is a considerable expansion in the manufacture of open-hearth steel, and production to-day is now above the average of pre-war days. A good many furnaces are still out of operation, but there is a favourable prospect of a number of these being lighted before long. Crucible steel makers are quiet, and orders are comparatively hard to obtain. The war surplus of this material continues to drug the market, high-speed steel being offered at something like a third of the price asked for new material. Until this Government surplus is disposed of it is useless to expect any revival in new business. It is also stated that German high-speed steel is on offer at low figures, but apparently there is not much of it about. In the market for semi-products business is fairly good, with dealings in billets at the increased prices active, while soft basic qualities have moved up a further five shillings. The demand for acid billets is improving, but they are not so much inquired for as basic material. The tinplate market reports a steady demand, and is firm at the latest official schedule of prices, viz., I.C. 20 x 14 x 112 sheets, 20s. per box, f.o.b. Bristol Channel ports. Some makers, however, are asking 3d. more than the minimum. The new minimum price carries with it a discount of 1 per cent. to the merchants, but the latter refuse to be content with this, and there is every possibility of a conference in the near future to discuss the matter.

Scrap.

The increased activity of demand for certain qualities of scrap iron and steel recently reported is well maintained, and markets generally indicate a more hopeful feeling, although, of course, some little time must necessarily elapse before trade can possibly return to anything like normal conditions. In the Middlesbrough market last week buying was on a more restricted scale, in view of the impending holidays, and, if anything, the price of heavy steel scrap was a shade weaker, the best figure obtainable just now being in the region of 68s. 6d. per ton, delivered works. Heavy cast-iron scrap, machinery quality, in handy pieces, has stiffened a little, and 75s. to 77s. 6d. per ton, delivered works, can be obtained this week. Good heavy steel turnings and good clean cast-iron borings are in demand, at prices in the region of 55s. per ton, delivered works. Heavy wrought-iron scrap, ordinary piling quality, can be disposed of at a price approximating 72s. 6d. per ton, delivered works, and £4 per ton can be obtained for good heavy forge iron.

IRON AND STEEL MARKETS.—*Continued.*

Metals.

Copper.—Movements in the standard copper market of late have continued very steady, fluctuations in values being confined within fairly narrow limits, seldom ranging beyond fractional proportions from day to day. A firmer undertone is, however, in evidence, influenced by more hopeful views of the position in the U.S.A., where consumption is on an expanding scale. The Continental demand generally is also on a heavier scale, and altogether the position of this metal shows good promise for the coming year. New York advices state that a large interest in the Chili Copper Company has been acquired by the Anaconda Company. Doubtless it is thought that the latter concern, in their capacity as both producers and consumers, will, to some considerable extent, be able to control prices of the metal, and this possibly accounts for a good deal of the firmness of the market across the Atlantic. Current quotations :—*Cash*: Wednesday, £62 5s.; Thursday, £62 15s.; Friday, £63 10s.; Monday, £64 2s. 6d.; Tuesday, £64. *Three months*: Wednesday, £62 17s. 6d.; Thursday, £63 10s.; Friday, £64 5s.; Monday, £64 17s. 6d.; Tuesday, £64 17s. 6d.

Tin.—The position in the standard tin markets evidences a firm tendency. Consumers, however, continue to hold off, and buying is generally in disappointing volume. Almost similar conditions are noted in the States, but in this case it is surmised that operators are not too well covered, and must shortly come into the market for fair quantities of metal. Exports of tin from the Federated Malay States in November are officially stated to have amounted to 2,857 tons, as against 2,837 tons in October and 2,800 tons in the corresponding month of last year. For the first eleven months of the current year the total quantity of metal exported aggregated 32,144 tons, compared with 31,011 tons last year and 32,090 tons in 1920. Current quotations :—*Cash*: Wednesday, £176; Thursday, £176 15s.; Friday, £176 15s.; Monday, £180 5s.; Tuesday, £180. *Three months*: Wednesday, £177 2s. 6d.; Thursday, £177 17s. 6d.; Friday, £177 17s. 6d.; Monday, £181 12s. 6d.; Tuesday, £181 10s.

Spelter.—During the past week values in the spelter market have evidenced a reaction to lower levels, and the volume of business passing has been limited in tonnage. Rudolf Wolff & Company report that consumers in this country have rather refrained from buying, though a little more inquiry is noticeable as the week closes. Reports from America point to renewed firmness there, and similar conditions obtain on the Continent, where seemingly no stock of metal exists. Current quotations :—*Ordinary*: Wednesday, nominal; Thursday, nominal; Friday, nominal; Monday, nominal; Tuesday, £38 10s.

Lead.—The business passing in soft foreign pig is quiet and steady, with prices subject to very few fluctuations of importance. Consumptive demand continues in fair volume at home, but Continental buying is disappointing in volume. Current quotations :—*Soft foreign (prompt)*: Wednesday, £26 2s. 6d.; Thursday, £26 2s. 6d.; Friday, £26 2s. 6d.; Monday, £26; Tuesday, £25 12s. 6d.

Deaths.

MR. W. SLOAN, of Elmwood Villa, Bramley, died on December 16 after a brief illness. Mr. Sloan, who was 73 years of age, was one of the founders of the firm of Sloan and Davidson, Limited, ironfounders, Stanningley. He went to Leeds from Scotland about 35 years ago, and shortly afterwards commenced business, in partnership with Mr. William Davidson, at the Carrick Foundry, Kirkstall Road. Some years ago the firm removed to Stanningley.

COLONEL JOHN M'AUSLAND DENNY, C.B., D.L., chairman of the firm of William Denny & Brothers, Limited, shipbuilders and engineers, Dumbarton, died on December 16 in a nursing home in Glasgow. Colonel Denny, who was in his 65th year, was widely known in shipbuilding, engineering and shipping circles all over the United Kingdom. His father was the late Peter Denny, LL.D., founder of the world-famous firm now known as William Denny & Brothers, Limited, a firm which had contributed in a very remarkable degree to the prosperity and development of the burgh in which its works are situated.

Acieries de Sambre-et-Meuse.—This French concern reports for the financial year ending June 30, a surplus of 6,395,926 fcs. (say, £100,000 at current rate), and is to distribute a dividend and super-dividend aggregating 250 fcs. net per share (50 per cent.). The amount carried forward is equal to over 6 per cent. on the share capital which stands at 4,000,000 fcs.

Company News.

Dollis Engineering Company, Limited.—Capital £1,500 in £1 shares. Directors: C. G. H. Adam and A. H. Harrison.

Broughton Copper Company, Limited.—Interim dividend, 5 per cent., less tax, on both ordinary and preferred shares.

Harry N. Booker, Limited, Wellington Garage, Foundry Street, Barnsley.—Capital £5,000 in £1 shares. Engineers.

Atlas Steel Foundry Company, Limited.—Loss, £13,791; surplus brought forward converted into adverse balance of £9,798.

Fosse Foundry Company, Limited, Ivy Cottage, The Fosse, Syston, Leicester.—Capital £1,000. Directors: C. R. Carter and W. Hunt.

J. H. Carruthers & Company, Limited, Polmadie, Glasgow.—Capital £33,000 in £1 shares. Engineers. Directors: J. Gourlay and M. Jackson.

Adams Non-Ferrous Metal Company, Limited, 71, Legge Street, Birmingham.—Capital £3,000. Permanent managing director: H. F. Adams.

Hills' Dry Dock & Engineering Company, Limited.—Loss, £807; credit balance brought in, £18,008; carry forward, £17,201; ordinary dividend passed.

A. J. Jackson, Limited.—Capital £5,000 in £1 shares (4,000 preference and 1,000 ordinary). Engineers. Directors: J. H. Woodington, A. J. Jackson, and A. H. Miles.

Hertford Engineering Company, Limited, 3, Blenheim Street, London, W.—Capital £12,000. Permanent directors: J. T. Sanders (chairman), R. Forster, E. C. Maylin, R. W. Richards and J. Wing.

North Lonsdale Iron and Steel Company, Limited.—Depreciation, £2,000; credit balance, £12,460; brought forward, £17,654; total, £30,114; dividend, 5 per cent., less tax; carry forward, £17,773.

Kent Construction & Engineering Company, Limited, 79, Mark Lane, London, E.C.—Capital £30,000. Directors: T. Haig, T. H. Board, W. R. Honeywell (managing director), F. Wakeman and D. A. Dwyer.

Armstrong Whitworth Development Company, Limited.—Dividend, 6 per cent. per annum, less tax, on preference for half-year, making 6 per cent.; carry forward, £16,675; ordinary dividend, 12½ per cent., free of tax.

Metalcraft, Limited, 6, Windmill Street, London, W.1.—Capital £2,000 in £1 shares (1,000 preference and 1,000 ordinary). Brass finishers, bronzers, etc. Directors: H. Jones (managing director), C. E. Overton and F. Yoxall.

Lloyd & Rider, Limited, Nile Street, Birmingham.—Capital £12,000 in £1 shares (4,600 preferred ordinary), to adopt an agreement with D. C. Lloyd, and to carry on the business of brassfounders, metal stampers and piercers, etc.

Personal.

VISCOUNT LONG, ex-First Lord of the Admiralty, has joined the new board of directors of Henry Bessemer & Company, Limited.

THE LATE MR. W. J. LLEWELLYN, of Park Road, Redditch, retired engineer, left gross estate of the value of £10,928, with net personalty £9,916.

MR. RICHARD SMITH, of Drigg, Cumberland, has been elected chairman of the Cumberland Iron Ore Proprietors' Mutual Indemnity Society, in succession to the late Mr. W. E. Walker, of Woodend. Mr. Smith is a member of the Advisory Committee of the Cumberland Conciliation Board (Iron Industries), and is also manager of Ainsworths Margaret Mine, and of Stirlings iron mines in Cumberland.

Gazette.

MESSRS. J. REED, F. Parr and W. E. Glover, engineers, 205, Jack Lane, Hunslet, Leeds (trading under the style of Reed & Glover), have dissolved partnership. Mr. J. Reed Continues.

THE PARTNERSHIP heretofore subsisting between Messrs. S. G. Railton and S. J. Aldcroft, engineers and ironfounders, 53A, Seel Street, Liverpool, under the style of Railton & Aldcroft, has been dissolved.

AT THE EXPIRATION of three months the names of the undermentioned companies will be struck off the Register of Joint Stock Companies and the companies will be dissolved: Agricultural Implements Manufacturing and Supply Company, Limited; Barron Expanding Ferrule Company, Limited; Elliott Jones Vertical Coke Oven Syndicate, Limited.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 23, ROYAL EXCHANGE SQUARE, GLASGOW.
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.
CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*

THE "CLIMAX"

A HIGHLY DEVELOPED PLANT AT A COMPETITIVE PRICE, AND A SOUND INVESTMENT.

Capacities of Molten Iron from 10 cwt. per hour for the *fixed type set*, and from 5 cwt. per hour in the *hinged type set*.

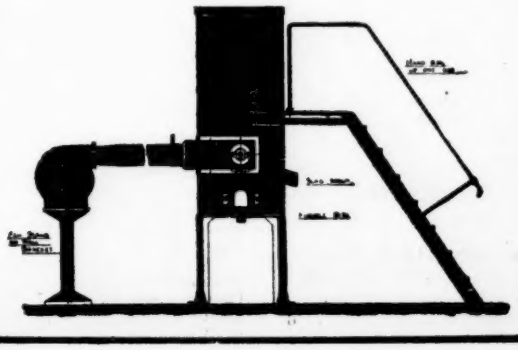
Drawings and prices given for Complete Foundry Melting Equipment, embodying our "Climax" Cupolas from 5 cwt. to 15 tons capacity of molten iron per hour.

E. ROPER & CO., Foundry Equipment Engineers,

71, North St., KEIGHLEY.

Phone: 595. Grams: "Climax."

Emergency CUPOLA Equipment,
with Fixed Type Furnace.



WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	64	0	3
Three months	64	17	6
Electrolytic	70	10	0
Tough	66	10	0
Best selected	66	10	0
Sheets	96	0	0
India	84	0	0
Wire bars	70	7	6
Do. Jan.	70	7	6
Do. Feb.	70	7	6
Ingot bars	70	5	0
H.C. wire rods	74	0	0
Off. aver. cash, Nov. 62	17	0	9/11
Do. 3 mths., Nov. 63	14	3	9/11
Do. Settlement Nov. 62	17	1	10/11
Do. Electro, Nov. 70	9	3	9/11
Do. B.S., Nov.	66	8	9
Aver. spot price, copper, Nov.	62	16	1 3/4
Do. Electro, Nov.	70	14	3 3/4
Solid drawn tubes			13½d.
Brazed tubes			13½d.
Wire			10½d.
Yellow metal rods			6½d.
Do. 4x4 Squares			8½d.
Do. 4x3 Sheets			9½d

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extruded or rolled	6½d.
Sheets to 10 w.g.	10d.
Wire	9½d.
Rolled metal	9½d.

TIN.

	£	s.	d.
Standard cash	180	5	0
Three Months	181	10	0
English	180	0	0
Bars	182	0	0
Chinese	178	0	0
Straits	182	0	0
Australian	181	10	0
Eastern	184	10	0
Banca	181	0	0
Off. aver. cash, Nov.	179	8	9 1/2
Do. 3 mths., Nov.	180	3	5 1/2
Do. Sttlment Nov.	179	8	7 7/11
Aver. spot, Nov.	179	7	3¼

SPELTER.

	£	s.	d.
Ordinary	38	10	0
Remelted	35	10	0
Hard	28	0	0
Electro 99.9	44	0	0
English	38	10	0
India	29	0	0
Prime Western	38	10	0
Zinc dust	49	0	0
Zinc ashes	11	0	0
Off. aver., Nov.	36	18	9
Aver., spot, Nov.	38	0	2¾

LEAD.

	£	s.	d.
Soft foreign ppt	25	12	6
English	27	0	0
Off. average, Nov.	25	12	2 1/2
Average spot, Nov.	26	3	5½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	42	0	0
Do. V.M. ex. whf.	43	0	0
Dutch	43	0	0
Rods	50	0	0
Boiler plates	41	0	0
Battery plates	43	0	0

ANTIMONY.

	£	s.	d.
English regulus	27	0	0
Special brands	33	10	0
Chinese	25	0	0
Crude	17	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	12	2	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	£11 7 6
75%	£20 0 0
Ferro-vanadium—	
35/40%	17/- lb. va.
Ferro-molybdenum—	
70/75% c. free	9/6 lb. mo.
Ferro-titanium—	
23/25%, carbonless	1/1½ lb.
Ferro phosphorus, 20/23%	£24
Ferro-tungsten—	
80/85%, carbon free	1/5 lb.
Tungsten metal powder—	
98/99%	1/11 lb.
Ferro-chrome—	
4/6% car.	£23 10
6/8% car.	£22 10
8/10% car.	£21 10
Ferro-chrome—	
Max. 2% car.	£54 0
Max. 1% car.	£65 0
Max. 0.70% car.	£73 0
67/70%, carbonless	1/7 lb.
Nickel—99%, cubes or pellets	£130 0
Cobalt metal—98/99%	11/6 lb.
Aluminium—98/99%	£95
Metallic Chromium—	
96/98%	4/6 lb.
Ferro-manganese (net)—	
76/80%, loose	£15
76/80%, packed	£16
76/80%, export	£14 10
Metallic manganese—	
94/96%, carbonless	2/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ½ in. to ¼ in. by ¼ in., and all sizes over four times in width over thickness — 3d. lb.
Bevels of approved sizes and sections — 6d. lb.
If in coils — 3d. lb.
Packing — £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces — 3d.
Turnings and swarf — 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.
South Wales—			
Heavy Steel	3	17	6
Bundled steel & shearings	3	5	0
Mixed iron & steel	3	10	0
Heavy cast iron	3	15	0
Good machinery for foundries	3	10	0
Cleveland—			
Heavy steel	3	8	6
Steel turnings	2	16	0
Cast-iron borings	2	16	0
Heavy forge	4	0	0
Bushelled scrap	3	12	6
Cast-iron scrap	3	15	0
Lancashire—			
Cast iron scrap	3	15	0
Heavy wrought	3	10	0
Steel turnings	2	2	6

	£	s.	d.
London—			
Copper (clean)	37	0	0
Brass (clean)	32	0	0
Lead (less usual draft)	23	0	0
Tea lead	20	0	0
Zinc	22	10	0
New aluminium cuttings	64	0	0
Braziery copper	48	0	0
Gun metal	44	0	0
Hollow pewter	150	0	0
Shaped black pewter	90	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	91/-
Forge No. 4	82/6
Mottled	81/6
Hematite No. 1	93/9
Hematite M/Nos.	93/-
Midlands—	
Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast, ord.	190/-
„ „ roll iron	200/-
„ basic	—
Northants forge	70/- to 72/6
„ foundry No. 3	77/6 „ 80/-
„ basic	80/-
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland—	
Foundry No. 1	99/6
„ No. 3	94/6
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	85/6
„ foundry No. 3	87/6
Lincs. forge	86/6
„ foundry No. 3	87/6
„ basic	86/6
E.C. hematite	104/2
W.C. hematite	105/- to 110/-

All d/d in the district.

Lancashire (d/d eq. Man.)	—
Derby forge	—
„ foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	109/6
Glengarnock foundry	111/6
Gartsherrie foundry	111/6
Monkland foundry	109/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.
Iron—			
Bars (or.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	12	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, ¾ in. × 4 in.	16	10	0
Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tees	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	10	0
Rounds, under 3in. to ¾in.	9	0	0
Flats, over 5in. wide and up	9	15	0
Flats 5in. to 1½in.	9	0	0

	£	s.	d.
Rails, heavy	8	15	0
Fishplates	13	10	0
Hoops	11	10	0
Black sheets, 24 g.	11	15	0
Galv. cor. sheets, 24 g.	17	7	6
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	11	15	0
Billets, soft	6 10 0 to 7	0	0
Billets, hard	7 0 0 to 8	0	0
Sheet bars	6 17 6 to 7	0	0
Tin bars	7 7 6 to 7	13	9

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	29.14
No. 2 foundry Valley	25.50
No. 2 foundry, Birm.	23.00
Basic	26.96
Bessemer	31.77
Malleable	28.96
Grey forge	26.77
Ferro-manganese 80 % delivered	100.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	36.50
O.-h. billets	36 50
O.-h. sheet bars	36.50
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.27
Steel bars	2.00
Tank plates	1.95
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/-
„ furnace	25/-
Durham & North. fdy.	27/6 to 30/-
„ furnace	22/6 to 25.6
Other Districts, foundry	25/- to 30/-
„ furnace	21/6 to 24 6

SWEDISH IRON.

Bars, hammered basis sizes. Basis price £22 to £23

	£ s. d.
Rolled Ordinary—Assortment ..	18 0 0
Nail Rods—Square, round and flats ..	to 18 10 0

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	..	57½%
Water	..	52½%
Steam	..	47½%

Tube prices are now free.

TINPLATES.

I.C.Cokes,	20×14, box	20/1½
„	28×20, „	41/-
„	20×10, „	29/3
„	18¾×14, „	20/10½
I.X.	„	47/-
I.X.X.	„	53/-
F.C.B.Y.	21×13¾ „	38/-
C.V.B.G.	16¾×15, „	36/-
I.C.W.	20×14, „	18/4½
„	28×20, „	36/9
„	20×10, „	26/3
„	18¾×14, „	19/1½
Terneplates,	28×20, „	37/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Dec. 13	62	5	0	dec.	5/-
„ 14	62	15	0	inc.	10/-
„ 15	63	10	0	„	15/-
„ 18	64	2	6	„	12/6
„ 19	64	0	0	dec.	2/6

Electrolytic Copper.

Dec. 13	68	10	0	dec.	10/-
„ 14	69	0	0	inc.	10/-
„ 15	69	10	0	„	10/-
„ 18	70	0	0	„	10/-
„ 19	70	10	0	„	10/-

Standard Tin (cash)

Dec. 13	176	0	0	inc.	10/-
„ 14	176	15	0	„	15/-
„ 15	176	15	0	No change	
„ 18	180	5	0	inc.	70/-
„ 19	180	0	0	dec.	5/-

Tin (English ingots)

Dec. 13	176	0	0	inc.	10/-
„ 14	176	15	0	inc.	15/-
„ 15	177	0	0	„	5/-
„ 18	180	0	0	„	60/-
„ 19	180	0	0	No change	

Zinc Sheets (English)

Dec. 13	42	0	0	No change
„ 14	42	0	0	„
„ 15	42	0	0	„
„ 18	42	0	0	„
„ 19	42	0	0	„

Spelter (ordinary).

Dec. 13	—			Nominal
„ 14	—			„
„ 15	—			„
„ 18	—			„
„ 19	38	10	0	—

Lead (English)

Dec. 13	27	5	0	No change
„ 14	27	5	0	„
„ 15	27	5	0	„
„ 18	27	5	0	„
„ 19	27	0	0	dec. 5/-

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

SHROPSHIRE IRON Co., Ltd.

Works:—
Hadley, Shropshire.

London:—10, Fush Lane, Cannon St., E.C.4.

Telegrams:—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

Telephone:—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEED, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

LATE PRODUCTION MANAGER of well-known firm desires position; experience in Engine and Ordnance Work, Colliery and General Engineering.—Apply, W. LAING, 4, Main Road, Handsworth, Sheffield.

THE Lancashire Branch of the Institution of British Foundrymen beg to announce that several members, who have had varied experience as Foremen, etc., are at present disengaged. Employers who are in need of Foremen or other members of their foundry staff are invited to communicate with the Honorary Secretary, T. MAKEMSON, 21, Beresford Road, Stretford, Manchester

SITUATION required as Steel Moulder; active, strong and healthy; age 50 years; 22 years in last situation, 10 years as under-foreman; shop doing approx. 50 to 80 tons per week; castings to 3 tons; general engineering and locomotive; able to take charge. Member of F.M.B.S.; no other society.—Box, 314, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Strand, London, W.C.2.

WANTED.—FOUNDRY FOREMAN, experienced in moulding large marine castings and general heavy machine tool castings.—Apply, THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Chesterfield.

WANTED, Foreman for Aluminium Foundry. Must have good experience in this metal and be good organiser, with intimate knowledge of modern machine moulding. Only keen men need apply.—Box 312, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—FOREMAN PATTERNMAKER, experienced in heavy marine engine, general machine tools and special pipe patterns.—Apply, THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Chesterfield.

PATENT.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

ADVERTISER is prepared to sell his Special Mixture and method of making Chilled Rolls. This process has been used successfully for over 20 years.—Further particulars, apply Box 306, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

MACHINERY.

"BREAKIR" Improved Foundry Sand Disintegrators and Mixers (capacities from one to ten tons per hour), obtain many improvements. Write for leaflets and quotations to the makers, W. BREALEY & COMPANY, LIMITED, Russell Street, Sheffield, or their Agents.

NINE nearly new Steel Hopper Wagons, standard gauge, roller bearings.

Two sets of Belt-driven Geared Hydraulic Pumps, 2-in. rams and 4-in. rams.

Brand new 4-ft. under-driven Sand Mill.

10-kw. Steam-driven Lighting Set, 110 volts D.C.; bargains.

HARRY H. GARDAM & COMPANY, LIMITED, STAINES.

COMPLETE New Portable Cutting Plant, £15 10s.; approval. Welding Plant, with six blowpipes, £22, including expert tuition at customer's works; approval. Cutting Blowpipes, unused, but soiled, £3; 1922 pattern.—STANSELL'S ACETYLENE COMPANY, LIMITED, Exeter.

CASTINGS.

Modern Foundry equipped for weights up to 10 or 12 tons. Keen prices. Best quality.

Enquiries solicited for pattern making. Good deliveries.

Wm. ASQUITH (1920), Ld.

Highroad Wells Road - - - - HALIFAX.

MACHINERY.—*Contd.*

Ladle and Carriage (Stevenson's), the ladle being 3 ft. 4 in. dia. at top, 2 ft. 8 in. dia. at bottom, 3 ft. 4 in. deep; 5 ft. gauge of carriage. Set of "Krom-type" Crushing Rolls, 30 in. dia. by 15¾ in. wide, having manganese steel shells, two nests of springs, tightening screws. Perforated Grinding Mills, over-driven, 7-ft., 9-ft., and 10-ft. sizes. 3-ft. Loam Mill, under-driven, with two cogged rollers, 18 in. dia. by 6 in. wide. Three "Peter's" Single-chain Grabs, each about ¾ cub. yd. capacity. "Priestman" Single-chain Grab, 1 cub. yd. capacity, four teeth each side. Five Swing Jibs, each comprising 8 ft. vertical upright, jib radius 8 ft., 20 in. by 9 in. "Goodwin-Barsby" Stone Breaker, fitted with "Era" manganese steel jaws.

Catalogue of Stock Machinery, 6,000 Lots, Free on application. Inspection invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

TENDERS

STEEL BEAMS, 550, Schedule S.A.634 (17th January).—Tenders are invited by the Commonwealth of Australia for the supply of the above, closing on date indicated. For Tender Forms and full particulars apply SUPPLY OFFICER, Room 101, Australia House, Strand, London, W.C.2.

MISCELLANEOUS.

To THE EDITOR of the Foundry Trade Journal.

Please send me details of the visit to the International Foundry Trade Congress and Exhibition to be held in Paris next September.

Name.....

Address.....

.....

Swift — Metallic — Stopping

THE BRITISH FOUNDRY CEMENT for filling up Blow Holes in Castings. It dries in one hour and it can be filed up from 6 to 12 hours.

SAMPLE FREE—AGENTS WANTED.

THE SILENT MACHINE CO., Savile Street, SHEFFIELD.

FOUNDRY REQUISITES.

Try our REFRACTORIES.

Ganister or Silica Bricks and Blocks (any shape or size). **Sands, Cements, Ganister.**—*Let us have your enquiries.*

THE CLEVELAND MAGNESITE & REFRACTORY CO., LTD., Normanby Brickworks, Normanby, Eston, Yorks.

AN ORDINARY OPPORTUNITY

250 Tons of excellent JOBBING BOXES, in useful sizes, with excellent fittings including Pipe and Column Boxes up to 28 ft. long, and ordinary flat top parts up to 14 ft. by 8 ft., offered at **£7 per Ton** on rails London—cannot be cast under double the money.

ODD BOXES SUPPLIED.

AN EXTRAORDINARY OPPORTUNITY

Jobbing Foundry FOR SALE AS A GOING CONCERN. Owner retiring; old-established business S.W. London. Capacity 50-60 tons weekly. Price to quick buyer **£2,500**, including all fixed plant and buildings

ALEX. HAMMOND, Foundry Machinery Expert, BOXTED, SLOUGH.